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CHANGES IN MENTAL FUNCTIONS AFTER INDUCED HYPOTENSION

IMMEDIATE AND LATE EFFECTS OF OPERATIONS UNDER HYPOTENSIVE ANESTHESIA ON CEREBRAL FUNCTIONS

BY

MATS GRUVSTAD LARS KEBBON

AND

BENGT AX:SON LÖF

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Preface

The mental sequels of operation and anesthesia have seldom been studied with an experimental technique. The consequence is that it is usually difficult to determine how much any observed sequels are due to the anesthesia, how much to the operation, and how much to other factors. In the present study we have attempted to examine the mental effects of operation under hypotensive anesthesia by comparing groups as much as possible alike except for the induced hypotension.

We began collecting data from preoperative and immediate postoperative examinations in the spring of 1958, and made our late follow-up examinations in the summer of 1960.

We have signed our names separately to the chapters for which we are mainly responsible in this book, but all three of us are responsible for the work as a whole.

Our investigation would not have been possible without the support of the heads of many institutions, of whom we should particularly like to mention Professors Bernhard Jacobowsky, Hans Forssman, Torsten S:son Frey, Martin H:son Holmdahl, Gunnar Johansson and Carl Hirsch.

We have also benefited from the suggestions and criticisms of several other colleagues, including Börje Cronholm, Ingmar Dureman, Daisy Schalling, Gunnar Ström, Henry Sälde, and Eric Österberg.

We are indebted to Margareta Hedén for doing the psychometric follow-up testing, to Kerstin Forsman for help with the illustrations, to Vivi Wendin and Janos Hegedüs for help with the statistical calculations, to Martin Juhlin for constructing the apparatus, and to the nursing and office staffs of the Orthopedic and Anesthesiologic Departments of the University Hospital and Ulleråker Research Centre for clerical aid and various forms of personal assistance.

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For all this help, we wish to extend our sincere thanks.

Uppsala, April, 1962.

Mats Gruvstad
Lars Kebbon
Bengt Ax:son Löf

CHAPTER 1

Survey of Relevant Literature

by Mats Gruvstad

Sequels of Severe Oxygen Deprivation

A large amount of attention has been given to fatal anoxia, perhaps mostly to the pathologic observations after nitrous oxide anesthesia (Lucas 1950, Courville 1955). It has been shown in studies of these complications, and also in studies of strangulation, carbon monoxide poisoning, birth injuries, high altitude accidents, and cardiac arrest during operation, i. e., in severe oxygen deprivation of every source, that some parts of the central nervous system are more sensitive than others to oxygen want (Steegman 1939, Monrad-Krohn 1956, Courville 1955, Welner 1955). The pyramidal cells of the cerebral cortex and the Purkinje cells in the cerebellum and basal ganglions seem to suffer most from deprivation of oxygen. Courville (1953 b) noted that an oxygen deficit also caused damage to the white matter, and that circumscribed lesions developed secondarily to the progressive changes in the cerebral vessels.

The clinical course of acute major anoxia is well known. In fatal cases it leads to coma, sometimes interrupted by delirium; sometimes the patient survives for a comparatively long period, then often in a state of great dementia combined with severe neurologic disorders (Monrad-Krohn 1956 and others). In nonfatal cases, when the brain has been less affected by the deficiency, the patient comes out of the stupor in a psychotic, delirious condition, and this is followed by amnesia and a clinical picture like that in the Korsakoff syndrome. The mental disorders may vary greatly from person to person, however, and may consist of disorders like emotional lability, euphoria or hypomania in some people and various kinds of depressive states in others; in some motor hyperactivity, in others negativism and passivity. Lowering of the intellectual level in these conditions may vary between an insignificant impairment and complete dementia (Steegman and Davis 1950, Courville 1953 a, b, Lucas 1950). Some of the defects may persist afterwards and may

get worse with time because of secondary vascular changes. However, the reports of resuscitation after cardiac arrest mention mostly minor residuals, if any, after the accidents. This may be due to the fact that cases of a favourable outcome are more likely to be reported than others, or to the lack of systematic study of the patients' conditions before the accidents for proper appraisal of the sequels. It is evident from the literature, however, that persons who survive severe or moderate oxygen deprivation exhibit various degrees of intellectual impairment, sometimes of the type Goldstein (1948) called concrete behavior, and other kinds of disorders, differing from person to person.

Sequels of Mild Oxygen Deprivation

It has been suggested by Monrad-Krohn (1956) and Courville (1953 b) for example, that psychoneurotic conditions may be caused by mild cerebral lesions after low-grade anoxia, in the same way as severe mental sequels follow severe anoxia. Several observations give indirect support to the possibility of this connection, but some authors who distinguish between organic and neurotic disorders say it is out of the question (Müller 1956).

During recent years, however, several experimental studies have been made which should be able to give a more direct answer to these questions. Thus there have been many reports from institutes of aviation medicine on the mental effects of confinement in decompression chambers, of hypoxia, and of exposure to acceleration (Hardmeier and Knoepfel 1956, Rossen and Simonson 1961). Several authors have reported unfavourable mental or even fatal effects after the hypoxia in simulated high altitudes or induced by great acceleration, the earliest effects observed being lowering of the level of consciousness and fluctuations in the degree of wakefulness. On prolonged exposure, impairments in memory, power of concentration and judgment were observed, together with a reduction in associative ability and emotional control. Thus Frankenhaeuser (1956, 1958) observed a prolonged reaction time and an impairment in time perception during radial acceleration, presumably provoked by the hypoxia. Hardmeier and Knoepfel (1956) found that the scores in a test requiring sustained attention got worse on exposure to simulated high altitudes. In their opinion the results indicated the presence of a reversible organic brain injury. When oxygen was given the results returned to what they were before. They pointed

out that previous research had shown that mild hypoxia resulted in neurastheniform disorders of a different nature than the signs of organic psychosis developing on acute anoxia. The question is, however, whether this difference between "neurastheniform" and "organic" is not one of quantity rather than quality. All the neurasthenic signs they described could equally well be called manifestations of organic lesion. In all these experiments, however, the subjects were deprived of oxygen for only a short length of time, and there was no reason to expect sequels of lasting nature.

Changes in Mental Functions after Operation and Routine Anesthesia

Postoperative psychiatric disorders have long been a center of interest and numerous investigations have been done to study these conditions from different points of view (Kleist 1916, Foster 1949, Hunter 1949, Hackett and Weisman 1960, Janis 1958, Benson and Reinand 1960). Knox (1961) gave a review of the reports in this field. The pathogenesis of these disorders has been explained in different ways. The list of explanations suggested includes toxic ill-effects, anesthetic accidents or great loss of blood during the operation, premorbid maladjusted personality, preoperative fear, and the difficulty in the case of elderly persons of getting accustomed to hospital routine. Later years have brought a large number of reports of mental disorders after cardiac surgery (Freeman et al. 1954, Bliss et al. 1955). In recent research by Zaks (1959) and Zaks et al. (1960) attention is focussed on the possible connection between cerebral lesions and postoperative mental disorders (Schnaper 1961, Haugen 1961). Common to several earlier studies is that about the same type of mental disorders have been observed postoperatively and little effort has been spent on systematic comparisons and checking of other factors that might have caused the mental disorders. The investigations of a few authors, e. g. Lindemann 1941, Sørensen and Lindenberg 1950, Zaks 1959, based on an experimental design have given important results. However, the manner of the connection between mental disorders, on the one hand, and the surgical and anesthesiologic factors, on the other, has not been penetrated to any great extent.

Sørensen's and Lindenberg's investigation (1950) seems to be one of the first to try to make a systematic study of the sequels occurring directly after routine anesthesia. They were unable to detect any

difference between groups subjected to different forms of anesthesia, but they only compared psychometric results in the groups. They made no analysis of the patients' own impressions as to how their minds were affected, or of the psychiatric sequels of the lesions caused by the anesthesia; nor was their material homogeneous from the surgical point of view. Later on Morpurgo and Galli (1957) compared intelligence test scores before and after orthopedic operations, but their results do not give any distinct information one way or the other.

Jaffe and Bender (1951) studied the perceptual processes during recovery from routine surgical anesthesia. They found that sensory discrimination was impaired for an astonishingly long time after the anesthesia. On touching two different places on the skin simultaneously, usually beginning with the cheek and contralateral hand, they found that the reduction in perceptual capacity, whether extinction, obscuration or displacement, was of the same order as that occurring in severe cerebral disease. As it was easy for the subjects to learn how to improve their scores in this test, however, it could not be used for testing later on, when there was less disorder in consciousness and amnesia. These authors did not present any surgical data. Lambrechts and Parkhouse (1961) have recently presented interesting results from a study of the length of post-operative amnesia. Their findings pointed to the length of the amnesia being dependent on the degree of cerebral involvement.

It is apparent, accordingly, that disorders in mental functions of the kind observed after anoxia and organic lesion also occur during recovery from ordinary, uncomplicated anesthesia.

Changes in Mental Functions after Induced Hypotension

Sokoloff (1959) surveyed the observations concerning pharmacologically induced changes in cerebral circulation, including the ones caused by hypotensive anesthesia with ganglionic blocking agents, differential sympathetic block or high spinal anesthesia. It seems to be agreed that induced hypotension only affects the cerebral circulation indirectly, by causing a change in the systemic blood pressure. When the blood pressure is reduced the cerebrovascular resistance decreases, with the result that an adequate flow of blood is maintained. This mechanism operates to different degrees in different people; persons vary in their ability to tolerate these changes, probably because of differences in the anatomy of

their cerebral vessels (Wells 1960). When the threshold tolerance for hypotension is exceeded, hypoxia sets in, as manifested by electroencephalographic abnormalities and reduction of the cerebral blood flow (Gough 1955, Wyke 1960). The same observations are made in persons who are conscious and persons under hypotensive anesthesia, but it should be emphasized that the conditions during surgical procedures under hypotensive anesthesia incur a further strain, and further reduce the capacity to stand stress, especially if arterial hypertension is present beforehand (Kleinerman et al. 1958, Saklad 1962).

Little (1955), analyzing a large collected series, found that delayed awakening accounted for 22 per cent of 908 complications associated with this form of anesthesia, and interpreted this to be produced by anoxia. There have been several reports of permanent mental impairment or death after complications during induced hypotension (Armstrong Davison 1953, Little 1955), particularly with the head-up body tilt and in elderly persons. Greene et al. (1954) reported impairment in performance in "a battery of psychomotor tests" and clinical signs of cerebral lesions after operations under hypotensive spinal anesthesia in a series of 35 cases. The mental symptoms consisted of vagueness of thought, conceptual difficulties, depressive and confusional reactions, faulty attention and impaired recent memory. However, they made a few similar observations in a small control series of operations done under normotensive anesthesia. From this they drew the conclusion that the operation itself also affected mental functions (Gray 1956). Berg (1958) reported a series of 50 cases operated on under hypotensive anesthesia, in which preoperative and postoperative tests of flicker fusion frequency with evipan indicated that a large proportion of the patients had got "moderately severe brain injuries". It may have been, however, that the impairment of cerebral functions in Berg's patients were caused by manipulations with cervical arteries during the operation (Ask-Upmark 1935, Sokoloff and Kety 1960). It is not possible to draw any definite conclusions bearing on the present study from Berg's observations, since it is well known that there is a marked disparity between low cerebral blood flow and clinical signs of cerebral ischemia (Alman and Fazekas 1957, Lassen et al. 1957). Furthermore, several authors have reported series in which there were no definitive untoward effects (Gordon and Ladenheim 1955, Åkerlund and Dahl 1959) and some authors believe that the risk of cardial or cerebral complications can be obviated if the

arterial blood pressure is not allowed to drop below a critical level (Rollason and Hough 1960, 1961, Saunders 1954 and others). This opinion has been criticized by Wyke (1959) and Saklad (1962), referring to earlier observations by Armstrong-Davison (1953) and others.

As seen, the results of earlier studies are contradictory in some respects and it is difficult to draw any definite conclusions from them concerning how much the untoward mental effects observed after operation under induced hypotension are due to the hypotension, or whether the effects are likely to be of permanent standing.

CHAPTER 2

Present Study. Design, Material and Statistical Methods

by Mats Gruvstad and Lars Kebbon

Points of Enquiry

The points of enquiry in the present study were:

1. Does induced hypotension during operation lead to disorders in mental function?
2. If so, do these disorders persist for as long as a year afterwards?
3. If so, how do these disorders affect the subject's adjustment to society, working capacity and subjective well-being?

Analysis of these problems requires an experimental approach, with experimental and control groups as much as possible alike in every respect except the hypotension, not only in physical, but also in mental respects, including the stress caused by the anesthesia and operation, and earlier mental disorder (Gray 1956, Janis 1958, Haugen 1961, Henrie et al. 1961).

Design

We decided to study two groups of cases operated on for herniated lumbar discs, one under hypotensive and the other under normotensive anesthesia. We tried to have these groups as much as possible alike. Thus we tried to get the same age, sex and IQ distribution in both of them. We also kept close watch on all other factors that could conceivably affect the results of any comparisons between the groups, e. g., length of interval between myelography, examination and operation (Thorsén 1947), amount of analgesics received, premedication, duration of anesthesia (Lambrechts and Parkhouse 1961), extent of operation and complications during operation.

In order more exactly to define the extent of mental alteration after operation under the two forms of anesthesia, an unoperated group was also included in the study. It was meant to have the patients in this group the same as the operated groups in physical condition and expectation of operation, as well as in age, sex and

IQ distribution, but this requirement could not be fulfilled in entirety.

These three groups were subjected to psychiatric and psychometric analysis. By utilizing the intraindividual change from the preoperative to the postoperative examinations as measures for comparisons between the groups, each patient was made to act as his own control (McNemar 1955).

In the psychiatric analysis, it was attempted quantitatively to compare the mental condition of the patients operated on under hypotensive anesthesia with the others by rating a number of psychiatric items in each case. These items included five that are usually used for describing changes in mental functions after cerebral lesion, particularly changes in cognitive and conative functions, as well as three that could be assumed to affect the observations in the present material, i. e., the degree of pain, amount of mental tension and basic mood. These items are taken up in detail in chapter 5.

The psychometric study also attempted to assess the condition of functions which earlier research had shown to be affected by cerebrolesional conditions of different origin, particularly impairments of mild nature, as well as functions observed to be temporarily impaired by deficiency of oxygen. A survey of the literature on this subject has been given by several authors, including Klebanoff et al. (1945, 1954), Yates (1954), Klopfer et al. (1952), Dureman (1953), Meyer (1961) and Frankenhaeuser (1958). Similar psychometric methods to the ones used here have formerly been used for studies of brain injury and other conditions (Gruvstad and Kebbon 1958, Kebbon and Gruvstad 1958, Dureman and Sälde 1960, Norrman and Svahn 1961, Dureman, Sälde and Österberg 1962). The reasons the tests used in this study were chosen have also been taken up previously (Kebbon 1960).

Defects commonly observed after mild cerebrolesional disorders and different forms of physical stress are disorders in general psychomotor tempo, both in rate of immediate response and in rate of continuous activity. Deterioration has also been observed in power of integration, the capacity of sensorimotor coordination and ability to shift, as well as in functions that are difficult to define in operational terms, like concentration and attention. When choosing the psychometric battery for this study, it was attempted to collect a number of measures constructed for sampling individual aspects of psychomotility, though it was realized that it is impossible to isolate specific functions, e. g., sensory, perceptual and motor functions, or to distinguish them from integrating ones.

The battery chosen was also one which could be used over again with the same subjects on several different occasions. Consideration had also to be given to various practical circumstances, especially to the state of the patients immediately before and after their operation. The separate tests are described in chapter 4.

The changes noted between the time before and after the experimental condition is introduced are greatly dependent on the amount of time that expires between the two examinations. For this reason, we arranged to follow the same time schedule in each case, and decided for practical reasons to examine the patients one or two days before operation and three to seven days afterwards, and use the corresponding timetable in the unoperated cases.

The psychiatric examinations were scheduled as follows: To begin with, often immediately after the patient was admitted, the first psychiatric appraisal of the condition, called the pre-appraisal, was made. After the operation, or corresponding day in the unoperated cases, another psychiatric appraisal, called the immediate post-appraisal, was made. About a year and a half later, a late post-appraisal was made.

The psychometric examinations were scheduled as follows: The patients were given the test battery on two occasions during the first and second day before the proposed operation; these were called the first and second pretests. The fourth and sixth day after operation or after the corresponding intervals in the unoperated cases, they were given the battery twice more; these were called the first and second immediate posttests. About a year and half later, the battery was given once more; these were called the late posttests.

The double blind design was used for both the psychiatric and psychometric analysis, neither the psychiatrist nor psychologist knowing what form of anesthesia had been employed or anything about the results of other examinations, and the patients not knowing about the real purpose of the investigation (see also p. 57).

One of us (M. G.) did all the psychiatric examinations. The other (L. K.) did all the psychometric testing of the patients while they were in hospital. Miss Margareta Hedén did the psychometric testing after they left hospital.

Material

All the patients had been admitted to the Orthopedic Department for observation or operation because of severe back pain and sciatica.

The choice between hypotensive and normotensive anesthesia for the separate subjects was made at random by the anesthetist until 40 cases had been collected. When this happened, he was given the intelligence quotients in these 40 cases, and from then on he tried to make the groups alike for age, sex and intelligence quotient. The decision for or against operation was made by the orthopedist in charge of the department.

It was not possible to examine all the patients according to the whole of the original schedule, for example, because the patient was operated on the day after he was admitted, or because he was discharged too early for our plan, or for some other reason irrelevant to this study. The cases which were examined completely according to our plan amounted to 24 in the hypotensive anesthesia group, 24 in the normotensive group and 11 in the unoperated group.

In the incompletely examined cases, sometimes the whole psychiatric examination was carried out as planned, but not all the psychometric testing, and in others the reverse was true. While this was a disadvantage in some ways, in others it was an advantage, for whenever the results of the psychometric and psychiatric analyses of groups of partly different composition agree, if anything, it increases the reliability of the conclusions drawn from them.

In the psychiatric section of the study, the changes at the immediate post-appraisal were compared in a hypotensive anesthesia group of 26 cases, a normotensive anesthesia group of 26, and an unoperated group of 12 cases. The changes at the late post-appraisal were compared in 26, 33 and 12 cases of the corresponding categories.

In the psychometric section of the study, the results of the pretests and immediate posttests could be analyzed in 28 hypotensive anesthesia cases, 28 normotensive anesthesia cases and 19 unoperated cases. It was impossible for various reasons to give all these cases the second immediate and late posttests. The changes in the second immediate posttests, accordingly, could only be compared in 24 hypotensive anesthesia cases, 24 normotensive anesthesia cases and 13 unoperated cases. At the late posttesting, 5 originally unoperated subjects had to be transferred to the normotensive group. The changes at this testing, therefore, were compared in 28 hypotensive anesthesia cases, 32 normotensive anesthesia cases and 12 unoperated cases.

A few cases were included, though it had been impossible to give them the whole of the test battery on some occasion, because of some-

thing wrong with the apparatus, the patient's general condition or some other reason immaterial to the comparisons. A number of subjects who had been examined psychometrically before the operation could not be followed after the operation and were excluded from the psychometric material. There was no reason to believe that the omission of these cases had a systematic influence on any results of relevance to the study.

Statistical Methods

The observations in this study were not appropriate for analysis with parametric statistical tests. The significance of the observations was therefore tested throughout with nonparametric tests (Siegel 1956).

McNemar (1955) came to the conclusion that the best method to test significance in a study using pretests and posttests in an experimental and control group was to test the significance of the difference (D) between changes (d) from the pretests to posttests. Calling the two groups A and B, therefore, and with M denoting the means of the observed data, this would be expressed as

$$D = d_A - d_B$$

where $d_A = M_A \text{ pre} - M_A \text{ post}$, and $d_B = M_B \text{ pre} - M_B \text{ post}$.

There were several ways in which Mpre and Mpost could be determined in the psychometric study. In order to take advantage of the stabilization which may be assumed to have taken place at the second pretest, the score at this test was used as the reference point for the change from pretest to posttest. As it was interesting to follow the performance at different stages after the operation, the changes were calculated separately from the second pretest to the first, second and late posttest. These changes were calculated for each individual.

The statistical analysis was done in the following way.

The means and standard deviations for the various psychometric scores for each of the three groups were calculated. These are seen in table 4, which also shows the ranges.

The changes in the three main groups and subgroups (Chapter 3) were taken as the means of the individual differences between the

second pretests and the scores at the three posttests (table 5). *The higher the negative change or the lower the positive change in the psychometric score the greater the postoperative impairment in function.*

A special analysis was done to determine how the groups differed in combinations of tests. As the scores of the separate tests differed greatly in dispersion, there was no point in only adding the raw scores of the tests. The most common procedure in these cases is to convert the raw scores to standard scores, and then add the standard scores (Cronholm and Schalling 1958). It was chosen in the present study, however, to add the ranks of the scores. The individual changes in the scores from the second pretest to each of the three posttests for the subjects of all three groups were ranked in a single series. For each subject, the ranks in the individual tests were added together. The sums so obtained were then treated as raw scores when the difference between the groups in combinations of tests were tested for significance. Two combinations were tried: firstly, a combination of all the tests and, secondly, a combination of the four test variables which differentiated most between the groups and whose first pretest scores were little correlated, i. e., choice reaction time, finger dexterity (2), mirror tracing (total time), and identical forms (table 3).

The psychiatric ratings for each individual and changes in ratings are given in tables A and B of the appendix. The means and medians of the ratings for psychiatric items at the pre-appraisal and immediate post-appraisal are given in table 6. Changes in the ratings at the immediate and late post-appraisal were calculated in the same way as in the psychometric scores, and the groups compared for these changes, first all three groups (tables 7 and D appendix) and then the two operated groups (tables 8, 12 and 13). *The higher the positive and the lower the negative changes in the psychiatric ratings the greater the postoperative impairment in function.*

The significance of differences between the three groups in both the psychometric and psychiatric variables was tested with the Kruskal–Wallis analysis of variance by ranks (Siegel 1956) and differences between two groups with the Mann–Whitney *U* test (Siegel 1956).

The following formula was used for analysis by the Kruskal–Wallis method:

$$H = \frac{12}{N(N+1)} \sum_{j=1}^{k} \frac{R_j^2}{n_j} - 3(N+1)$$

where k = number of samples
n_j = number of cases in jth sample
N = n_j, the number of cases in all samples combined
R_j = sum of ranks in jth sample (column)
$\sum_{j=1}^{k}$ directs one to sum over the k samples (columns)

H is distributed almost the same way as chi square with k–1 degrees of freedom for samples of more than 5 cases (Siegel 1956). The H's were computed and used to decide whether observed differences among the groups were due to chance variation or not.

As it was predicted that the hypotensive group would show greater deterioration or less improvement than the other two groups and that the corresponding would be true of the normotensive and unoperated groups, one-tailed tests of the significance of observed differences were used.

For the Mann–Whitney U-test the following formulas were used:

$$U = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

where R_1 = sum of the ranks assigned to group whose sample size is n_1
n_2 = sample size of the larger group under comparison.

The U-values computed were used to decide whether observed differences were due to chance or not in comparisons where n_2 was less than 20. However, when larger samples were compared, z-values were computed, as the sampling distribution of U may then be assumed to approach the normal. The following formula was used:

$$z = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{\frac{(n_1)(n_2)(n_1+n_2+1)}{12}}}$$

The z's computed were used for determining the significance of observed U-values; thus, the significance of differences between the groups.

There were a large number of tied observations for the psychiatric variables. When computing the *H*'s and *z*'s, corrections for tied ranks were made according to the following formulas:

$$H = \frac{\frac{12}{N(N+1)} \sum_{j=1}^{k} \frac{R_j^2}{n_j} - 3(N+1)}{1 - \frac{\sum(t^3 - t)}{N^3 - N}}$$

where t is the number of tied observations in one tied group of scores and $\sum (t^3 - t)$ directs one to sum over all groups of ties.

$$z = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{\frac{n_1 n_2}{N(N-1)} \left(\frac{N^3 - N}{12} - \sum \frac{t^3 - t}{12} \right)}}$$

where t is the number of tied observations in one tied group of scores and $\sum \frac{t^3 - t}{12}$ directs one to sum over all groups of ties.

However, for the relevant differences between the hypotensive and normotensive groups, *z*-values were computed both with and without correction (table 8).

Differences between groups were taken as significant when P amounted to 0.05 or less. So as not to overlook any information given by the observations, some differences at probability levels over 0.05 were also discussed.

To analyze the relations between two separate variables or between variables and changes in other variables, the Spearman rank correlation coefficient was used. The formula used for these computations is described by Siegel (1956, p. 204).

CHAPTER 3

Anesthesiologic Section

by Bengt Ax:son Löf

MATERIAL

All the operations were performed for prolapsed lumbar intervertebral discs. All but one patient belonged to risk class I in the classification of the American Society of Anesthesiologists (Dripps et al. 1957), i. e., they were patients who had no organic disease or in whom the disease was localized and produced no systemic disturbance. This one exception (case 20) had mild, well controlled diabetes and belonged to risk class II in the same classification.

ANESTHETIC TECHNIQUE

Premedication

The premedication used is shown in table 1. As all but one patient had no complicating diseases, the majority were given morphine-scopolamine according to a scheme described by Gordh (1942).

Table 1. *Premedication in Cases Operated on under Hypotensive and Normotensive Anesthesia.*

Drugs Used for Premedication	Type of Anesthesia	
	Hypotensive No. of Cases	Normotensive No. of Cases
Morphine + scopolamine 0.5—1.5 ml. (Morphine 1 cg. and scopolamine 0.3 mg./ml.)	26	30
Pethidine 50 mg. Atropine 0.5 mg.	5	7
Phenergan 50 mg. Atropine 0.5 mg.	0	1
Glutetimid. 750 mg. Atropine 0.5 mg.	1	0
Atropine 0.5 mg.	0	1

Monitoring

The systolic pressure was taken by auscultation as soon as the patient was put on the operating table. It was taken again immediately before induction of anesthesia and at least every fifth minute during anesthesia. After trimethaphan was given the pressure was taken every or every second minute. Measurement of the diastolic pressure giving unreliable results during the hypotension, this was not recorded.

Anesthesia

Anesthesia was induced with an ultra-short-acting barbiturate. This consisted of Narkotal® (Isopropyl-betabromallyl-N-methyl-malonyl carbamide sodium 55 mg. per ml., Astra) in 29 cases in each group. The mean dose given in the hypotensive anesthesia group amounted to 470 mg. (between 300 and 660 mg.), in the normotensive group to 432 mg. (between 275 and 605 mg.). The other patients received Pentothal® (Thiomebumal-sodium 50 mg./ml., Abbott): 3 patients in the hypotensive group (mean dose 383 mg., between 250 and 500 mg.), and 8 in the normotensive group (mean dose 319 mg., between 250 and 400 mg.). When the patients fell asleep the lungs were ventilated with pure oxygen and succinylcholine chloride was given to facilitate intubation with a cuffed armoured endotracheal tube. The patients were coupled to a Marrett anesthetic machine, and arrangements were made for controlled ventilation with a flow of 2 l. of oxygen and 6 l. of nitrous oxide. When spontaneous respiration had completely returned, the expiratory half was blocked. Trilene® (Trichlorethylene, ICI) was then added to the system and the patient taken down to stage 3, plane 1 anesthesia. The gas flow was never reduced to below 8 l., this amount being enough to cover the respiratory minute volume except in the induction stage of Trilene anesthesia when the amount occasionally had to be increased. The oxygen concentration of the inhaled gases during this stage never fell below 25 per cent. If tachypnea set in (more than 25 breaths per minute) pethidine was given in doses of 12.5–25 mg. The total amount of pethidine given during the whole operation varied between 12.5 and 65 mg. in the hypotensive group and between 12.5 and 75 mg. in the normotensive group (see case reports, appendix). Fourteen patients in the hypotensive group and 16 in the normotensive group received no pethidine during operation.

When stage 3 plane 1 anesthesia was reached and the patient did not react to the endotracheal tube being moved about, he was then turned over into the prone position and lifted up into a special frame to avoid pressure on the abdomen and impairment of spontaneous respiration (Taylor et al. 1956, Hirsch 1959). The table was then tipped with the head inclined down about 15 degrees and the feet down about 25 degrees, the patient lying in an arched position with the operation area highest and with the feet somewhat lower than the head. The hands were placed on a special support in front of the head so that the upper arms were on the same level as the head.

The anesthesia was then continued as described below.

Hypotensive Anesthesia Group. Hypotension was induced with a dose of trimethaphan between 20 and 50 mg. (mean dose: 37 mg.) depending on the patient's age and the stability of the blood pressure during induction. Drip infusion with trimethaphan, 1 mg./ml. saline solution (0.9 per cent NaCl) was then begun. The infusion rate was adjusted to keep the systolic blood pressure between 70 and 80 mm. Hg. In 8 cases however, it was necessary to give additional small single doses of trimethaphan to keep the hypotension at this level. Details about the total trimethaphan doses are given in the case reports in the appendix. When hypotension was induced, the oxygen concentration in the inhaled atmosphere was increased to 50 per cent.

Towards the end of the spinal part of the operation, the trimethaphan was stopped. The blood pressure was then usually allowed to return to normal spontaneously, but in 14 cases a small amount of a vasopressor agent was given. In every case the blood pressure had risen to over 100 mm. Hg before the operation was finished.

Normotensive Anesthesia Group. When the patients were in position, 60–80 ml. of a 1: 170,000 adrenalin solution in saline were injected into the operation area; this never produced any palpable pulse arrhythmia, only mild, temporary rises in blood pressure. The gas volumes, trilene and oxygen concentrations were maintained approximately unchanged throughout the operation.

In both groups, the administration of trilene was stopped as soon as possible, up to 40 minutes before the end of operation. The length of time the trilene was administered is shown in case reports. It was always attempted to make up for the amount of blood lost

during operation. The patient was extubated, and his pharynx and trachea sucked out after he was turned over on to his back.

Choice of Anesthesia

Controlled respiration causes venous stasis followed by a reduced cardiac output as a result of the increased intrathoracic mean pressure. If a low mean pressure is used, this effect is not marked (Cathcart et al. 1958, Motley et al. 1948). However, if the patient is given a ganglionic blocking agent at the same time, it may be increased because of the reduced venous tone caused by ganglionic blocking (Whittenberger and Sarnoff 1950, Sarnoff et al. 1950) and the decreased capacity to build up a venous pressure gradient. For this reason we chose a method in which the patient was allowed to keep breathing spontaneously. With spontaneous respiration, moreover, it is possible to detect the onset of severe cerebral anoxia. By using a system without rebreathing, we did not need to be afraid of carbon dioxide retention, for there was never any respiratory depression because we always adapted the amount of fresh gas we gave to the respiratory minute volume.

When the present study was started in 1957, trichlorethylene was selected for the anesthesia as it seemed to be a good analgesic with little or no depressive action upon respiratory or circulatory mechanisms, provided that tachypnea could be avoided. The present evidence however, does not unequivocally bear out this opinion (Defalque 1961).

During the hypotension, the oxygen concentration was increased to 50 per cent to guarantee adequate oxygenation of the blood. This increase was unlikely to have caused any cerebral vasoconstriction of importance (Sokoloff 1959).

Variations in Anesthetic Technique

The technique described above was used routinely. However, in a number of cases the technique was changed for one reason or another; for example 5 patients in the normotensive anesthesia group (42, 62, 65, 66, 68) received halothane instead of trichlorethylene. With halothane, a temperature and flow rate compensated vaporizor (Fluotec) was used, and the concentrations were never

permitted to exceed 1.6 per cent during the induction nor 1.5 per cent during the operation. Bradycardia did not develop in any of these cases, but a hypotensive reaction occurred in one of them (65, see below). No cases of hypotensive anesthesia received halothane.

In one case (44) in the normotensive group, strong signs of tachypnea and arrhythmia developed as soon as trilene was introduced into the system. Because of this, the trilene was washed out and a circle system was used with controlled respiration and a total dose of 20 mg. of d-tubocurarine. Gas flows of 2 l. of oxygen and 6 l. of nitrous oxide were used during the whole anesthesia.

Discussion of Changes in Blood Pressure

It was possible to keep the systolic blood pressure between 60 and 90 mm. Hg during the hypotension in 75 per cent of the cases. Sometimes the pressure fell momentarily to lower levels at the beginning of induction. In isolated cases it was hard to hold the pressure down to the required level, sometimes because of an adrenalin swab in the operating field. Conditions in the individual cases are given in the appendix, where the lowest blood pressure recorded and the area inscribed by the blood pressure curve below 80 mm. Hg are noted. These areas were calculated by transferring blood pressure curves to charts, and measuring the inscribed areas by planimetry.

In the normotensive anesthesia group, only 3 cases showed a blood pressure fall of more than 25 mm. Hg from the preoperative value during the anesthesia. In one of these cases (65) it fell 25 to 50 mm. for 40 minutes. This was probably because of the halothane anesthesia and a moderate hemorrhage towards the end of the operation. In case 69 the anesthesia was followed by an insignificant reduction of 30 mm. for five minutes. In the third case (67) the systolic pressure fell 25–65 mm. down to 100 mm. for 60 minutes for no apparent reason.

An increase in systolic blood pressure of more than 25 mm. Hg above the preoperative level was noted in 12 cases in the normotensive anesthesia group. In the majority of these 12 patients, the elevation amounted to 25–50 mm. Hg and was mostly transient. However, in 4 cases (46, 48, 55, 56) the maximum increase in blood pressure was 60–75 mm. Hg, the mean increase amounting to 40–50 mm. during most of the operation. The elevation was probably

caused by the local application or injection of adrenalin in the operating field. Hypertension during anesthesia is not exceptional in routine operations of this kind. It seems unlikely that the rise in blood pressure in these cases would have changed the cerebral blood flow to such a degree as to make the cases unsuitable for the planned comparisons between hypotensive and normotensive anesthesia (Sokoloff 1959).

The course was complicated by a sudden hemorrhage in several cases. The patient lost over 800 ml. of blood in 2 cases (31 and 71), and between 300 and 800 ml. in 9 others, 4 cases of hypotensive anesthesia (6, 19, 25, 29) and 5 of normotensive anesthesia (44, 57, 58, 64, 65); this loss could not always be compensated for in full during the operation. These cases are taken up separately in chapters 4 and 5. Another 2 subjects in the hypotensive anesthesia group lost between 200 and 300 ml.; nor could these losses be made up for immediately. A loss of less than 200 ml. was not always made up for, being considered of minor importance.

Criteria Used for Dividing between Severe and Mild Hypotension

To classify the hypotension series according to the degree of effect on the cerebral circulation, a technique must be used for determining the cerebral circulation.

This can be done either directly, for example, with the nitrous oxide method of Kety and Schmidt (1945) or the radioactive Krypton method of Lassen and Munch (1955), or indirectly by simultaneous measurements of the cardiac output and peripheral circulation to a particular area. Work using the latter method is now in progress (Löf 1962).

However, bloodless recording of blood pressure is probably the commonest physiologic variable noted during routine clinical hypotension anesthesia.

To see whether there was a difference in the mental sequels after different degrees of hypotension, we chose the following three criteria for dividing roughly between severe and mild hypotension (fig. A). All three criteria agreed on 15 of the 32 cases being of the severe category and 9 being of the mild category.

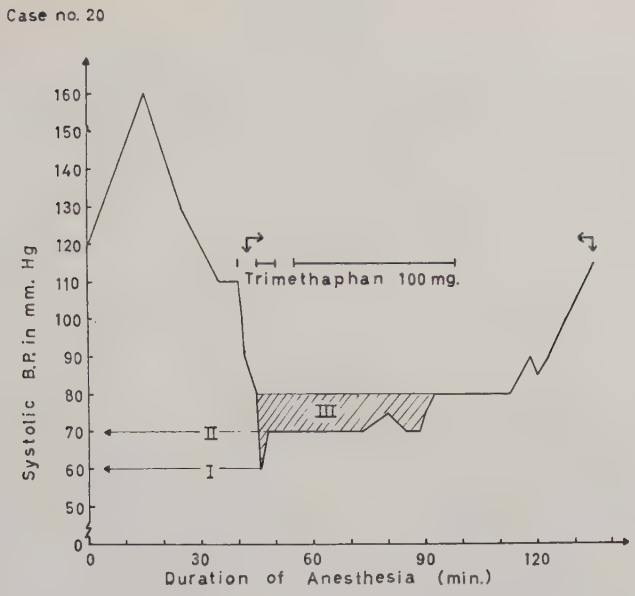

Figure A. The blood pressure during operation in case 20. I, the lowest to which the blood pressure dropped, II, the lowest pressure lasting for at least ten minutes on end, and III, the area inscribed by the blood pressure curve below 80 mm. Hg, or the hypotension area.

I. A fall in blood pressure at some time to 60 mm. Hg or under.

II. A fall in blood pressure to 70 mm. Hg for at least ten minutes.

III. A hypotension area, or area inscribed by the blood pressure curve below 80 mm., of 350 mm.^{2} or larger.

CHAPTER 4

Psychometric Section

by Lars Kebbon

METHODS

The same battery of tests was used at each psychometric examination: measurement of reaction time, finger dexterity test, mirror tracing test, identical forms test, measurement of flicker fusion rate, determination of serial tone-length judgment and the color-word interference test. In addition all the subjects were given the Dureman–Sälde test for general intellectual level, known as the SRB-test, at one of the pretests.

In order not to tire the patients too much with the large battery, the tests were given in the same order each time. The battery took an hour and a half, on the average, at each of the pre-examinations, and one hour at the post-examinations.

Reaction Time

The length of time taken for manual responses to audio-visual stimuli was determined. The subject was confronted with a panel with lamps distributed on it in a circle, like the numbers on a clock. The examiner lit the lamps in diametrically opposite pairs and the subject could put out the pair by pressing on a key in a board.

His simple reaction time was taken as the time it took him to put out a pair of lamps by pressing on a given key. His choice reaction time was taken as the time it took him to choose from three keys the one that corresponded to the pair of lamps that were lit, and then to put out the lamps.

The simple reaction time was then expressed as the mean time in 1/100 seconds taken to turn out the light in 10 trials, and the choice reaction time as the mean time in 40 trials.

Studies of the reaction time in brain damaged subjects made by Blackburn and Benton (1955, 1957) showed a delayed simple and

choice reaction time as compared with other subjects, the difference being most marked for choice reaction time. Ruesch and Bowman (1945) reported that acutely confused subjects had a longer simple reaction time than subjects with chronic disorders and even longer times than a normal group. Dencker and Löfving (1958) observed no difference between brain injured twins and cotwins in simple reaction time, but the brain injuries were relatively mild in their cases and a relatively long time had elapsed between injury and examination. Frankenhaeuser (1958) found that the reaction time was prolonged during radial acceleration. Burmeister (1939), Canfield et al. (1949, 1950) and Brown and Burke (1958) made similar observations during acceleration tests.

In a study of brain injured subjects we (Gruvstad and Kebbon 1958) found that their choice reaction times were longer than those of the average subject, but that their simple reaction times were shorter. Norrman and Svahn (1961) used the same tests for a follow-up study of severe brain injuries, testing the subjects at least two years after their accident, and found that they showed a prolonged three-choice reaction time.

Finger Dexterity

It was determined how quickly the subjects were able to insert small pegs into close-fitting holes in a board and to place small collars over the pegs and then to take the collars and pegs off again. This test is a modification of the tweezer dexterity test and aims to measure the rapidity and precision of finger movements (Dureman and Sälde 1959, Anastasi 1959).

The performance was scored on the number of seconds taken for putting on (1) and taking off (2) 50 pegs and collars.

There are several reports on disorders in finger dexterity after head injury, based on the observations in tapping tests, motor performance tests and the like. There is reason to believe that disorders of this kind are disorders in ability for integration and coordination, as well as in continuous attention, not solely primary disorders in motor ability (Klebanoff et al., 1954).

Earlier studies (Gruvstad and Kebbon 1958, Dureman and Sälde 1960, Norrman and Svahn 1961) have shown that this test is one of the best ones for differentiating between subjects with and without head injury.

Mirror Tracing

The mirror tracing test is a modification of Starch's mirror drawing test (1910), elaborated by Dureman, Sälde and Österberg (1958). The subject is required to draw a metal rod along a snaggy-sided star-shaped groove, which can only be seen by its reflection in a mirror. Whenever and as long as the rod touches the side of the groove, a buzzer sounds.

The result is scored for the total time, i. e., the mean numbers of seconds taken to complete the tracing five times, and the error time, i. e., the mean number of seconds the buzzer sounds in the five trials.

This classical test of visuomotor functions involves motor and perceptual functions and may be assumed to measure the capacity of sensorimotor coordination. The task also exposes the subject to stress, in that it presents him with conflicting perceptual cues and requires him to deviate from his earlier acquired habits. Dureman, Sälde and Österberg (1958) showed that with practice the test becomes more and more a test of the motor functioning of the hand. The more the subject is distracted or subjected to other forms of stress during the test, the greater, as a rule, the proportion of error time in the total time.

The mirror drawing test has been used for many different kinds of experimental research (see Wallen 1946, and Eysenck 1961). Eysenck used the test for measuring motor perseveration in different forms of abnormality. Dencker and Löfving (1958) used a variant for testing ability to shift, and found that it showed a significant difference in this ability between brain injured twins and their uninjured partners.

Identical Forms

The identical form test is one of Thurstone's (1938) primary mental ability tests. Dureman and Sälde (1959) standardized the test and subjected it to factor analysis with a Swedish normal population, and concluded that it measured perceptual speed and a capacity they called faculty to perceive visual detail. The patient is required to identify a stimulus figure in a series of five figures. The complete test consists of 60 identifications, the tasks getting more difficult with the order in which they are presented. For the purpose of this study, the test was divided into three subtests; the first, second and third part were given at the first, second and third examination,

respectively, and the first part given again at the second posttest and the late posttest.

The results were scored on the amount of seconds needed for solving all 20 tasks in the subtest, no attention being paid to error.

Testing of the validity of the Dureman–Sälde test battery (1959) showed that the identical form test was the one which most often discriminated between head injured and noninjured subjects (Gruvstad and Kebbon 1958, Dureman and Sälde 1960, Norrman and Svahn 1961). Cronholm and Schalling (1959) observed that patients with cerebral palsy did worse than controls in this test. Frankenhaeuser (1957) found impaired results in residual conditions after meningoencephalitis, but not during centrifugal acceleration of 3 g.

Flicker Fusion Rate

The flicker fusion rate is a measure of the capacity to discriminate intermittent visual stimuli. The frequency of flashes at which the patient first reported fusion, or threshold rate, was determined with a stroboscopic lamp, constant illumination and fixed point determination.

The score was given as the mean cycles per second of the threshold rate in six series of ascending and six series of descending flash rates.

Research has shown that many different conditions influence the flicker fusion rate: fatigue, alcohol, sedatives, oxygen want and cerebral dysfunction of different origin. (For a general outline, see Milfeldt 1957, and for special studies see Halstead 1947, Teuber and Bender 1949, Werner and Thuma 1942.) Halstead's observation that low grade anoxia affects the flicker fusion rate is of particular interest for the present study. Birren et al. (1946) found that determining the flicker fusion rate was the best method for measuring the effects of hypoxia at high altitude flying. Adler (1950) also found that it was a better method for revealing fatigue of the central nervous system than a motor performance test, choice reaction time and a tapping test. Keighley, Clark and Drury (1951) observed that the fusion threshold was not lowered by exposure to 3 g, but that it was significantly affected at 4 g.

Serial Tone-Length Judgment

The serial tone-length judgment test (Dureman, Holmkvist and Sälde, 1959) aims to measure the ability to keep attention focused

on an object, especially the propensity to fluctuation in attention. The subject listens to a series of tones of different lengths through headphones and is told that every time a tone is finished he is to press a key to produce a tone lasting an equally long time; he is given ten seconds for this before the next tone comes on. The test is kept up for 12 minutes and the lengths of the tones are varied according to a certain system (though in seemingly arbitrary order) between 0,2 and 2 seconds.

The responses are divided into 12 sets, each for five successive tones, and the subject is scored according to how well he differs between the relative length of the five tones in each set, the actual length of his responses being disregarded.

The method was described by Dureman, Holmkvist and Sälde (1959) who also tested its validity with subjects under the influence of sedatives and alcohol.

Color-Word Interference Test

Thurstone's modification of the Stroop test (Stroop 1935, Thurstone 1938, 1953) was used. This test aims to measure the ability for dissociation and also, to a certain extent, the ability to stand stress. It consists of three tasks, to read a series of names of colors (A), to name an equally long series of colors (B), and to name the colors in which an equally long list of words for other colors are tinted (C).

The scores were given in number of seconds needed for each of the three subtests.

This test has been found to differentiate between persons with and without an extravert temperament, the extravert persons doing better than the others because of their superior ability to dissociate (Thurstone 1953). Frankenhaeuser (1957, 1958) found that persons did worse in this test during radial acceleration and that the results were impaired after aseptic meningoencephalitis, especially in subtest B.

SRB Test

The SRB test (Dureman and Sälde, 1959) aims to measure the general intellectual level. It consists of three subtests: a synonym test (S), with 30 items measuring verbal capacity, scored according to the number of correct responses; a nonverbal test of reasoning ability (R), the figure classification test from Thurstone's primary mental ability tests, comprising 30 items, with scores corrected for chance;

Kohs' Block Test (B), a performance test measuring capacity of abstraction and of perceptual analysis and synthesis, one of the subtests of the Wechsler Bellevue Intelligence Scale, consisting of seven items and scored for accuracy and speed.

The raw scores for the three tests are added and the resulting sum is converted to an intelligence quotient corrected for age. The test has been standardized with a Swedish normal population. We have used it in earlier investigations (Kebbon and Gruvstad 1958, Gruvstad and Kebbon 1958).

Table 2. *Age and I. Q. Distribution in Present Series.*

	Hypotensive Anesthesia Group	Normotensive Anesthesia Group	Unoperated Group
Age in Years			
—19	1	1	0
20—34	4	5	6
35—44	13	17	8
45—54	6	4	4
55—	4	1	1
M	41.7	39.5	38.3
N	28	28	19
I. Q.			
— 89	3	6	2
90— 99	5	6	6
100—109	12	11	4
110—119	6	3	4
120—	2	2	3
M	103.9	100.9	105.5
N	28	28	19

RESULTS

Pretests and Immediate Posttests

General

The unoperated group of subjects showed a continuous improvement in performance from the first pretest to the second posttest. This improvement was such as might be expected from the effect of practice. There was a slight variation in this respect be-

tween the separate tests; for example, the simple reaction time was little affected by practice, as opposed to the scores for the mirror tracing test which showed a steep learning curve.

The scores of the operated subjects improved from the first to the second pretest, but usually deteriorated immediately after operation, and grew only slightly better at the second posttest.

As seen from table 4, the three groups of subjects were not exactly alike to begin with. Though there was no significant difference between them, the normotensive anesthesia group had slightly worse scores in most tests at the initial examination. This is a circumstance that might have affected the analysis of the changes in the groups in both directions and which makes it difficult directly to compare the scores of the three groups at the different occasions.

Nor did the groups differ significantly in their scores for the immediate posttests, though the normotensive anesthesia group continued to perform at a slightly lower level. The scores showed about the same dispersions and ranges in all three groups, without any systematic variation between groups. Thus none of the functions measured by these tests showed any *gross* disorder directly after the operation.

The hypotensive anesthesia group showed the greatest impairment or least improvement in scores from pretests to the immediate posttests. More exactly, this group showed the largest changes in scores in the negative direction or the smallest in the positive direction (table 5 and fig. 1–15). The reverse was true of the unoperated subjects.

Adding all the changes in the separate scores from the second pretest to the two posttests, more precisely, the ranks of the changes from pretest to posttest for each individual, to get a total change index (p. 20) for each group, revealed a significant difference ($P = 0.001$) between the three groups in this respect (table 3, fig. 14) to the detriment of the hypotensive anesthesia group. The change in the scores from the second pretest to the first posttest was greater than the change in the scores from the second pretest to the second posttest in both operated groups. Comparing the groups for these changes, however, showed that while the largest difference at the first posttest lay between the operated groups on the one hand, and the unoperated group, on the other, the largest difference at the second posttest lay between the hypotensive anesthesia group and the two control groups. All three groups differed significantly from each other in this respect on both occasions.

Table 3. *Differences between Groups in Changes in Combined Scores for all Tests and in Combined Scores for Choice Reaction Time, Finger Dexterity (2), Mirror Tracing (total time) and Identical Forms.*

Difference in Change from 2nd Pretest to:	Rank Mean			Significance of Difference between all tree Groups
	Hypotensive Group	Normotensive Group	Unoperated Group	
All tests				
1st posttest	47.9	40.8	22.1	P = 0.001
2nd posttest	41.0	26.9	20.2	P = 0.01
Late posttest	41.0	32.5	36.2	P = 0.50
Four tests				
1st posttest	44.3	33.7	22.9	P = 0.01
2nd posttest	32.4	22.7	21.3	P = 0.02
Late posttest	44.0	35.9	25.5	P = 0.01

Combining the scores for choice reaction time, finger dexterity (2), the identical forms test, and mirror tracing (total time) revealed significantly less improvement or greater impairment at the immediate posttests in the hypotensive anesthesia group than in the normotensive group, and in the normotensive anesthesia group than in the unoperated group (table 3, figure 15).

The hypotensive anesthesia group showed significantly greater impairment or less improvement than the normotensive anesthesia group and unoperated group in most combinations of tests including reaction time, finger dexterity, mirror tracing, and identical forms.

The changes in the scores for the separate tests in the battery point in the same direction, the hypotensive anesthesia group showing the most marked postoperative changes. However, a few significant differences emerged between the groups when they were compared test by test. The hypotensive and normotensive anesthesia subjects differed significantly in score shift in four tests and the normotensive anesthesia and unoperated group in three tests (table 5 and pp. 38–48).

As stated in chapter 3, three criteria were used for dividing the hypotensive anesthesia group into cases of severe and mild hypotension. Practically the same two subgroups were obtained in the psychometric material whatever criterion was used, the only disagreement being: The first criterion placed 3 subjects in the severe category which the second did not, while the second criterion placed 2 subjects in the severe category which the first did not. The second criterion placed 2 subjects in the severe category which the

third did not, while the third criterion placed 1 subject in the severe category which the second did not. Finally, the first criterion placed 3 subjects in the severe category which the third did not, while the third criterion placed 1 subject in the severe category which the first did not. As seen from table 5 and figure 11–13,[1] the severe hypotension group showed greater functional impairment, exhibiting the highest negative or lowest positive changes. As a rule, the groups did not differ significantly in the changes in the scores for the separate tests. Only in four tests did significant over-all differences occur.

Individual Tests

The tests which differentiated most between the groups were the ones calling upon motor functions and mental speed and flexibility (finger dexterity, identical forms, mirror tracing, and reaction time).

Reaction Time. The simple reaction times changed as predicted. Thus the unoperated subjects grew better from test to test. The normotensive anesthesia group did a little worse at the first postoperative test, but better at the second posttest. The hypotensive anesthesia group showed the greatest deterioration at the first posttest; it improved slightly at the second posttest but did not regain its preoperative level (fig. 1). The cases of severe hypotension deteriorated more than the rest of the hypotensive anesthesia group, which deteriorated to about the same level as the normotensive cases. The differences were not significant (table 5). The hypotensive anesthesia group had the slowest reaction times at the posttests and the unoperated subjects the fastest. All the groups had about the same reaction time in the pretests (table 4).

The choice reaction times grew continuously better in all three groups. The unoperated subjects improved most, the hypotensive anesthesia group least. In other words, the differences were as predicted between the operated and the unoperated subjects. The severe hypotension cases did not differ from the milder cases. The differences were not significant (table 5, fig. 2). The normotensive anesthesia group showed the slowest choice reaction time on every occasion, the unoperated subjects the fastest (table 4).

Finger Dexterity. The differences between the changes shown by the groups in this test were those that were predicted. The unoperated subjects' scores for the first part of the test (insertion)

[1] Results given according to criterion II, p. 29.

improved steadily from test to test. The normotensive anesthesia group did worse at the first postoperative test, but regained its preoperative level at the second posttest. The hypotensive anesthesia subjects deteriorated even more at the first posttest and did not return to the preoperative level at the second posttest (table 5, fig. 3). The cases of severe hypotension did worse after operation than the ones of less severe hypotension.

The three main groups differed significantly in finger dexterity. The normotensive and unoperated group differed significantly at the first posttest, and the hypotensive and normotensive group at the second posttest. The subgroups of the hypotensive group did not differ significantly, P amounting to 0.14 at the first posttest and 0.07 at the second. At the second posttest, however, the cases of severe hypotension differed significantly at the 3 per cent level from the normotensive group.

The normotensive anesthesia group did worse throughout the tests. The unoperated subjects did slightly worse than the hypotensive subjects in the pretests (table 4).

In the second part of the test (removal) the unoperated subjects did steadily better from test to test, the normotensive group slightly worse at the first posttest and the hypotensive subjects still worse after operation. The cases of severe hypotension showed greater impairment than the ones of mild hypotension at the first posttest, but the situation was reversed at the second posttest (table 5, fig. 4).

The three main groups differed significantly in change at the first posttest, but not at the second (table 5). The hypotensive subjects differed significantly from the normotensive subjects in change at the first posttest ($P = 0.04$) but not at the second, and the same was true of the normotensive and unoperated subjects ($P = 0.006$). The cases of mild and severe hypotension did not differ significantly.

The scores in the normotensive group were consistently worse than in the others. The hypotensive and unoperated groups lay at the same level in the pretests (table 4).

Mirror Tracing. All the groups grew steadily better in the total time taken for the test. The improvement at the first posttest was least marked in the hypotensive series, but at the second posttest this group showed about the same improvement as the normotensive anesthesia cases. The unoperated subjects improved most on both occasions. The cases of severe hypotension improved less after operation than the ones of mild hypotension (table 5, fig. 5).

Table 4. *Psychometric Results, Means, Standard Deviations*
A = Hypotensive Anesthesia Group (N = 28),
C = Unoperated Group (N = 19).

Test	Group	1st Pretest			2nd Pretest		
		M	S. D.	Range	M	S. D.	Range
Reaction time, simple	A	**36.5**	11.6	20—56	**37.3**	11.7	20—61
	B	**38.3**	13.7	19—78	**36.3**	14.7	19—86
	C	**37.7**	12.2	21—64	**37.6**	16.3	19—81
Reaction time, 3-choice	A	**153.9**	96.7	83—475	**112.6**	45.9	63—237
	B	**165.7**	67.0	77—363	**130.4**	62.3	68—202
	C	**144.3**	46.8	82—303	**116.2**	31.2	65—216
Finger dexterity 1	A	**169.9**	19.8	130—212	**159.7**	17.4	134—199
	B	**179.6**	30.8	135—236	**173.4**	32.0	127—230
	C	**171.5**	19.7	145—219	**163.4**	18.6	138—210
Finger dexterity 2	A	**71.7**	10.6	56—103	**66.8**	8.3	52—85
	B	**81.6**	11.2	64—102	**76.0**	12.4	57—98
	C	**72.2**	9.2	60—94	**68.9**	10.2	56—93
Mirror tracing, total time	A	**100.9**	38.2	32—179	**43.8**	31.3	16—124
	B	**94.8**	50.7	19—248	**49.1**	34.7	15—145
	C	**112.4**	60.2	34—293	**58.7**	39.5	24—157
Mirror tracing, error time	A	**41.9**	24.2	6—97	**19.3**	19.5	4—86
	B	**37.6**	19.8	11—95	**16.5**	9.9	5—42
	C	**35.2**	33.8	3—141	**12.8**	14.1	2—65
Identical form test	A	**170.6**	49.2	112—291	**140.2**	33.2	86—222
	B	**177.3**	63.8	112—313	**159.4**	63.7	103—259
	C	**156.9**	38.5	103—220	**140.4**	16.5	77—202
Flicker fusion rate, ascending	A	**39.7**	2.8	35—45	**40.4**	2.4	35—44
	B	**39.1**	2.8	33—43	**39.8**	3.2	32—47
	C	**40.8**	2.0	35—46	**41.7**	2.5	36—46
Flicker fusion rate, descending	A	**40.4**	3.0	36—47	**40.8**	3.1	35—53
	B	**40.5**	2.1	35—44	**40.8**	3.2	33—48
	C	**41.5**	2.4	38—46	**42.0**	1.9	38—46
Tone-length judgment	A	**20.8**	7.5	8—36	**22.8**	8.2	8—48
	B	**24.5**	12.1	2—50	**25.4**	12.4	8—52
	C	**20.3**	6.2	4—30	**20.8**	7.3	12—42
Color-word interference A	A	**46.5**	6.0	37—59	**46.3**	5.5	38—59
	B	**53.4**	7.1	37—64	**51.7**	6.7	39—64
	C	**49.4**	5.5	42—63	**48.7**	5.8	37—60
Color-word interference B	A	**72.4**	11.0	55—94	**68.0**	10.5	54—83
	B	**83.1**	16.7	50—116	**79.4**	17.4	44—161
	C	**73.8**	9.4	56—95	**70.6**	9.7	54—90
Color-word interference C	A	**141.2**	32.3	101—177	**128.0**	31.3	98—166
	B	**156.0**	56.7	78—230	**145.2**	52.1	64—219
	C	**133.6**	19.0	93—172	**121.4**	18.8	94—154

and Ranges of the Scores on all Five Test Days
B = Normotensive Anesthesia Group (N = 28),

1st Posttest			2nd Posttest			Late Posttest		
M	S. D.	Range	M	S. D.	Range	M	S. D.	Range
40.0	15.3	20—75	**38.0**	15.3	20—68	**43.8**	22.0	19—113
36.9	13.6	23—81	**34.7**	12.7	20—63	**45.3**	21.0	20—103
35.3	13.1	19—63	**32.5**	14.8	17—71	**45.2**	22.4	18—88
109.7	40.9	59—210	**97.8**	32.2	57—194	**110.4**	50.1	44—273
124.3	34.3	73—196	**110.0**	33.7	69—200	**119.5**	47.0	59—230
103.8	24.6	58—155	**87.5**	23.9	56—134	**110.9**	21.8	82—163
170.8	24.0	143—247	**162.6**	21.8	130—234	**152.1**	17.5	120—186
182.4	34.3	143—250	**169.4**	29.4	120—226	**156.9**	23.4	122—234
162.2	20.7	132—210	**153.3**	15.8	135—188	**165.0**	32.0	135—233
71.0	11.6	54—93	**63.7**	7.6	52—86	**64.9**	9.5	49—92
76.8	11.5	62—95	**71.3**	11.4	56—102	**68.4**	12.2	53—112
64.5	10.2	50—92	**60.4**	7.6	49—80	**69.8**	12.8	54—103
30.1	20.2	10— 89	**18.1**	8.0	9—51	**38.3**	25.0	12—109
34.5	25.6	14—109	**23.6**	18.0	11—81	**38.7**	25.0	13—135
40.0	22.1	14— 84	**37.2**	22.4	14—81	**45.9**	18.5	17—74
13.3	11.3	2—54	**8.8**	6.8	2—36	**17.0**	13.3	1—65
12.4	8.4	4—38	**9.0**	4.4	5—22	**12.2**	7.5	3—40
8.2	9.7	1—45	**5.2**	4.2	2—19	**16.9**	16.9	1—61
177.8	41.3	117—253	**153.4**	37.6	94—260	**157.6**	40.4	100—277
189.3	52.0	111—274	**158.6**	59.1	102—228	**159.3**	49.9	75—260
165.6	20.4	84—232	**155.1**	45.2	79—223	**136.5**	57.5	85—221
41.5	2.8	37—45	**41.8**	2.8	37—45	**42.0**	3.7	36—52
41.5	3.1	32—47	**42.2**	4.9	33—59	**42.8**	5.7	31—63
41.4	2.1	38—46	**40.9**	2.5	33—44	**44.7**	3.8	36—51
41.9	2.9	37—47	**41.8**	2.6	37—45	**42.9**	5.3	34—53
41.4	2.2	37—46	**42.4**	4.1	37—57	**42.7**	5.8	31—61
41.3	2.6	36—45	**40.8**	0.7	38—43	**43.5**	3.2	37—48
27.9	10.9	6—60	**25.5**	9.4	8—42	**19.1**	6.7	4—32
31.9	15.4	6—64	**28.0**	14.7	6—76	**22.4**	10.0	4—48
20.0	10.3	2—40	**19.0**	9.0	8—32	**22.4**	9.7	8—38
47.7	6.3	37—69	**46.0**	4.6	38—57	**45.9**	6.3	35—59
52.0	6.9	39—66	**51.6**	7.8	37—65	**48.7**	6.6	32—62
48.3	6.1	40—64	**47.8**	5.6	40—61	**48.8**	5.5	40—57
68.4	17.2	57—86	**63.4**	16.1	56—83	**65.1**	9.0	53—90
82.0	19.6	47—125	**78.3**	17.4	44—100	**71.5**	14.2	42—110
68.8	10.2	53—85	**65.2**	9.2	53—86	**73.6**	12.7	48—95
129.8	33.7	93—178	**112.3**	19.4	88—162	**121.2**	24.9	92—193
140.7	40.4	61—231	**124.1**	30.2	60—177	**120.9**	27.5	63—186
123.6	24.5	83—180	**112.0**	22.0	81—156	**130.5**	23.1	95—187

Table 5. *Psychometric Results. Means and Standard Deviations of Differences between Scores on Different Test Days (Significance tested by Kruskal-Wallis one-way analysis of variance. For significance of differences between pair of groups see text, pp. 38–52)*

Test	Group	Difference between Scores at 1st and 2nd Pretest		Difference between Scores at 2nd Pretest and 1st Posttest		Difference between Scores at 2nd Pretest and 2nd Posttest		Difference between Scores at 2nd Pretest and Late Posttest	
		M	S. D.	M	S. D.	M	S. D.	M	S. D.
Reaction time, simple	A	−0.8	10.1	−2.7	11.4	−0.3	12.7	−6.3	18.4
	A_1			−4.7	8.1	−4.2	11.3	−16.5	24.0
	A_2			−1.6	13.9	3.5	12.8	3.7	11.7
	B	0	9.5	−0.6	7.0	2.8	10.4	−7.1	20.4
	C	−0.1	8.1	2.4	7.3	5.6	7.6	−12.0	15.7
				P = 0.50		P = 0.30		P = 0.10	
Reaction time, 3-choice	A	41.1	69.4	2.8	13.5	13.4	18.8	−1.8	27.3
	A_1			4.9	15.2	15.1	23.5	−0.4	30.7
	A_2			−0.8	10.3	12.6	12.5	−3.2	24.7
	B	35.3	50.0	6.1	18.8	17.5	19.1	4.3	37.1
	C	28.2	21.4	12.4	21.3	20.9	16.7	15.8	22.1
				P = 0.30		P = 0.70		P = 0.50	
Finger dexterity 1	A	10.9	11.2	−13.1	21.3	−5.3	21.3	5.7	14.4
	A_1			−17.6	19.1	−7.9	12.6	4.6	16.7
	A_2			−8.2	17.8	−0.9	15.4	7.6	12.3
	B	8.5	14.5	−8.1	18.5	3.3	17.3	6.9	14.0
	C	8.5	10.2	1.8	8.9	8.2	10.9	4.6	37.1
				P = 0.05		P = 0.10		P = 0.70	
Finger dexterity 2	A	6.4	5.1	−4.9	12.2	2.0	3.7	1.9	28.1
	A_1			−5.9	9.4	2.8	3.9	8.5	6.9
	A_2			−4.6	4.2	0.4	2.7	−0.2	5.5
	B	6.1	7.8	−1.5	7.0	2.1	11.1	3.7	30.4
	C	3.3	7.1	4.4	6.8	6.2	5.5	0.8	11.1
				P = 0.01		P = 0.20		P = 0.30	
Mirror tracing, total time	A	58.8	33.1	13.7	17.5	22.4	22.3	6.2	25.4
	A_1			8.6	9.2	18.2	18.7	11.5	31.6
	A_2			19.6	22.5	27.0	25.0	3.6	20.6
	B	45.7	34.6	14.6	15.6	21.8	15.1	10.5	19.6
	C	53.7	38.2	18.7	21.1	32.2	8.0	20.5	34.3
				P = 0.30		P = 0.50		P = 0.001	
Mirror tracing, error time	A	19.6	17.8	6.1	11.1	8.2	10.5	1.6	17.4
	A_1			3.9	7.2	5.3	5.8	−1.7	22.7
	A_2			8.6	14.0	11.5	13.2	4.1	14.3
	B	23.8	19.2	4.1	3.8	7.5	5.2	3.5	8.0
	C	22.4	23.6	4.6	5.7	8.6	12.2	3.5	19.8
				P = 0.70		P = 0.30		P = 0.30	

A = Hypotensive Anesthesia Group (N = 28), A_1 = Pressure Lowered below 70 mm. Hg for ten or more Minutes (n = 16), A_2 = Pressure not Lowered under 70 mm. or, if so, for less than ten Minutes (n = 12), B = Normotensive Anesthesia Group (N = 28), C = Unoperated Group (N = 19).

Test	Group	Difference between Scores at 1st and 2nd Pretest		Difference between Scores at 2nd Pretest and 1st Posttest		Difference between Scores at 2nd Pretest and 2nd Posttest		Difference between Scores at 2nd Pretest and Late Posttest	
		M	S. D.	M	S. D.	M	S. D.	M	S. D.
Identical form test	A	**30.4**	23.1	**−37.7**	28.8	**−15.9**	24.1	**−20.5**	32.1
	A_1			**−42.9**	26.1	**−34.2**	26.6	**−16.1**	33.7
	A_2			**−31.1**	20.1	**−8.7**	17.5	**−23.7**	30.6
	B	**18.6**	26.9	**−29.8**	43.8	**2.5**	22.3	**−10.9**	37.5
	C	**21.5**	37.1	**−21.7**	20.4	**−17.2**	33.9	**−9.2**	37.4
				P = 0.20		P = 0.20		P = 0.50	
Flicker fusion rate, ascending	A	**0.9**	1.9	**−1.3**	1.5	**−1.3**	1.7	**−1.7**	3.5
	A_1			**−1.3**	1.8	**−2.0**	1.3	**−2.1**	3.1
	A_2			**−0.9**	1.1	**−0.3**	1.8	**−1.7**	4.0
	B	**−0.5**	2.0	**−1.7**	1.9	**−2.6**	1.0	**−2.6**	4.4
	C	**−0.9**	1.1	**0.3**	1.7	**−0.3**	1.9	**−2.5**	4.0
				P = 0.05		P = 0.05		P = 0.80	
Flicker fusion rate, descending	A	**0.2**	2.0	**−1.1**	2.3	**−1.5**	2.7	**−2.3**	4.5
	A_1			**−1.4**	2.8	**−0.7**	3.8	**−1.6**	4.6
	A_2			**−0.7**	1.6	**−1.0**	2.1	**−3.5**	4.3
	B	**0.4**	2.0	**−0.6**	1.8	**−1.7**	2.7	**−1.9**	4.2
	C	**−0.5**	1.2	**0.7**	1.6	**0.6**	1.3	**−0.8**	3.5
				P = 0.02		P = 0.05		P = 0.80	
Time interval judgment	A	**−2.0**	7.2	**−5.1**	12.9	**−2.7**	10.3	**5.4**	8.2
	A_1			**−5.6**	9.8	**−6.0**	8.1	**5.1**	8.6
	A_2			**−4.5**	14.1	**0.9**	10.2	**7.3**	7.2
	B	**−1.2**	8.0	**−6.8**	11.5	**−1.6**	17.2	**1.9**	9.5
	C	**−0.5**	6.7	**0.8**	10.8	**0.3**	6.1	**−2.2**	11.2
				P = 0.20		P = 0.50		P = 0.30	
Color-word interference A	A	**0.1**	3.6	**−1.9**	3.5	**−0.5**	3.2	**2.3**	6.1
	A_1			**−3.4**	3.6	**−1.8**	2.5	**0.5**	2.5
	A_2			**3.1**	10.3	**5.3**	12.0	**3.8**	8.3
	B	**1.9**	4.8	**−0.3**	4.4	**0**	4.2	**1.5**	1.5
	C	**0.7**	5.1	**0.5**	4.7	**1.5**	4.0	**0.7**	5.9
				P = 0.05		P = 0.30		P = 0.80	
Color-word interference B	A	**4.3**	6.2	**−3.0**	5.7	**0.5**	6.5	**2.6**	6.8
	A_1			**−3.5**	6.9	**−1.4**	6.6	**3.7**	7.1
	A_2			**−1.2**	3.8	**0.5**	6.1	**0.2**	5.2
	B	**3.9**	9.5	**−2.5**	12.9	**2.0**	10.6	**5.0**	9.4
	C	**3.1**	6.7	**1.8**	7.5	**4.3**	3.3	**−3.2**	11.9
				P = 0.30		P = 0.30		P = 0.30	
Color-word interference C	A	**14.4**	15.3	**−1.8**	20.8	**13.9**	16.2	**5.3**	14.6
	A_1			**−0.8**	15.6	**14.1**	12.2	**5.4**	7.9
	A_2			**−5.8**	19.0	**6.6**	15.7	**−0.4**	3.2
	B	**17.0**	16.9	**5.3**	26.4	**21.0**	20.6	**8.9**	19.2
	C	12.2	15.4	**−2.2**	18.5	7.6	11.4	**−5.5**	21.2
				P = 0.90		P = 0.70		P = 0.10	

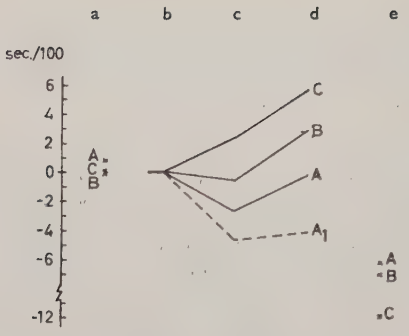

Fig. 1. Simple reaction time.

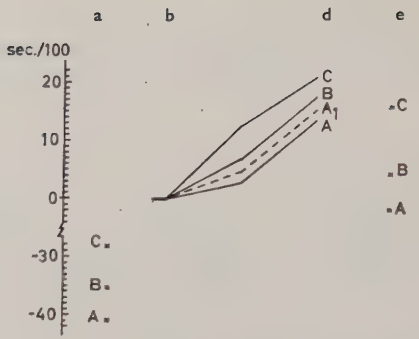

Fig. 2. Choice reaction time.

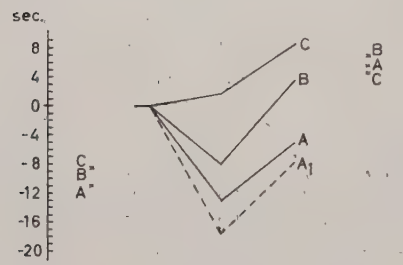

Fig. 3. Finger dexterity (1).

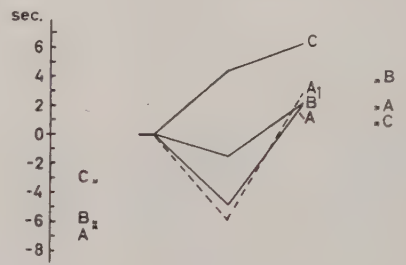

Fig. 4. Finger dexterity (2).

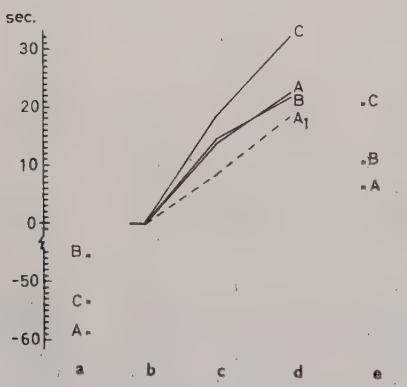

Fig. 5. Mirror tracing (total time).

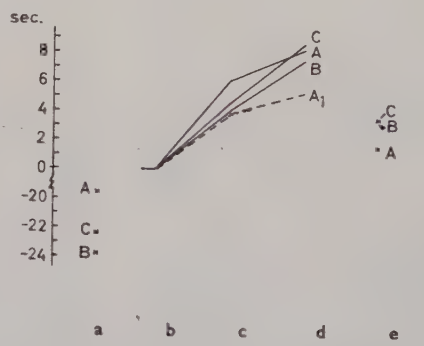

Fig. 6. Mirror tracing (error time).

Fig. 1–6. Changes from second pretest to posttests in psychometric scores. A = hypotensive anesthesia group; A_1 = severe hypotension group; B = normotensive anesthesia group; C = unoperated group. a = change from first to second pretest; b = second pretest; c = change from second pretest to first posttest, d = to second posttest, and e = to late posttest.

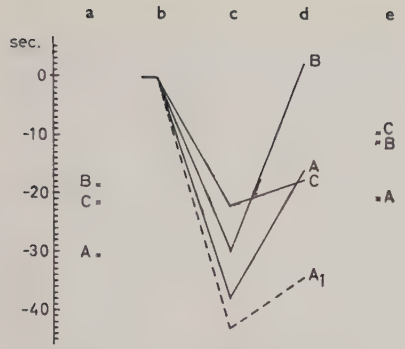

Fig. 7. Identical forms.

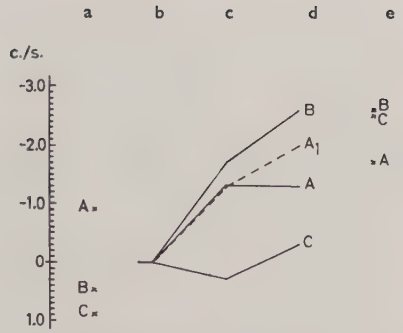

Fig. 8. Flicker fusion rate, ascending.

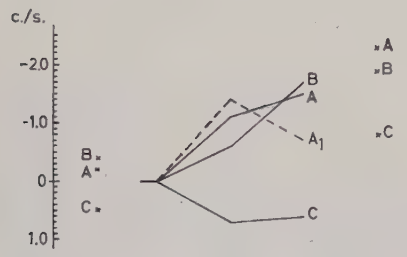

Fig. 9. Flicker fusion rate, descending.

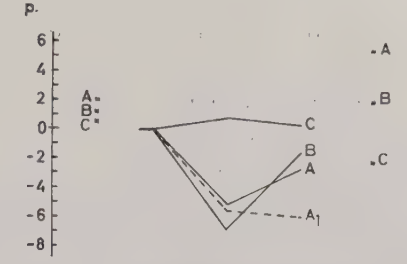

Fig. 10. Tone-length judgment.

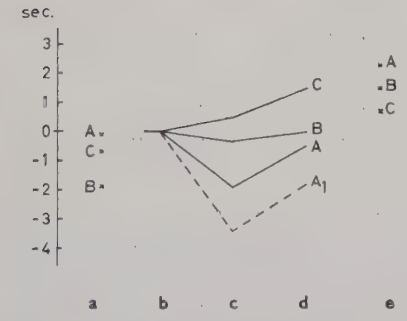

Fig. 11. Color-word interference test, A.

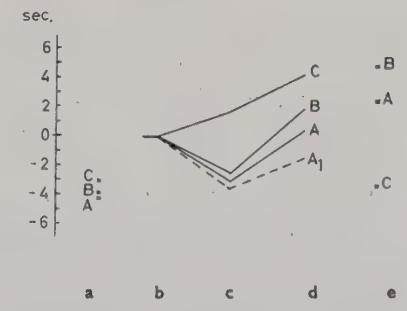

Fig. 12. Color-word interference test, B.

Fig. 7–13. Changes from second pretest to posttests in psychometric scores. A = hypotensive anesthesia group; A_1 = severe hypotension group; B = normotensive anesthesia group; C = unoperated group. a = change from first to second pretest; b = second pretest; c = change from second pretest to first posttest, d = to second posttest, and e = to late posttest.

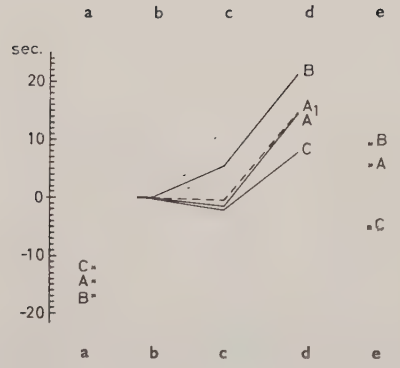

Fig. 13. Color-word interference test, C.

There were no significant over-all differences between the three main groups, but the cases of severe and mild hypotension differed significantly ($P = 0.04$).

The unoperated group had consistently worse scores than the other groups, but the two operated groups lay at about the same level to begin with (table 4).

All three groups showed a steady improvement in error time, and only small, indefinite differences in changes from test to test. The cases of severe and mild hypotension, however, differed as predicted (table 5, fig. 6).

The three main groups did not differ significantly. The cases of severe hypotension differed significantly from the ones of mild hypotension in changes at the second posttest ($P = 0.05$) but not at the first posttest ($P = 0.12$).

The hypotensive anesthesia group did consistently worse than the other groups, the unoperated subjects consistently better (table 4).

Analysis of the intra-test performance in the mirror tracing test revealed the greatest practice effect for total time in the unoperated group and the least in the hypotensive anesthesia group. This effect was more distinct at the first posttest than at the second. The over-all differences were not significant. The corresponding differences in error time were larger, being significant at the 1 and 5 per cent level at the first and second posttest.

Identical Forms. The results of the identical forms test were those that were predicted. The scores for this test showed a greater dispersion than for the others. All the groups did worse in the

posttests, particularly at the first post-examination when the hardest part of the test was given, and less at the second post-examination, when the part which was easiest and which had been used once before at the first pretest, was given.

The hypotensive anesthesia group showed the relatively greatest impairment in score in the posttests, particularly at the first posttest. The unoperated subjects showed the least impairment in the first posttest, but the same change at the second posttest as the hypotensive anesthesia group (table 5, fig. 7).

The cases of severe hypotension showed more impairment at both posttests than the ones of mild hypotension.

The over-all differences in changes between the groups were not significant. However, the hypotension group did significantly worse than the other operated group at the second posttest ($P = 0.01$), when the cases of severe hypotension also did significantly worse than the normotensive group ($P = 0.004$). The two hypotensive subgroups did not differ significantly in this respect, however. As it is not certain which is the best way to describe the situation statistically in this particular case, the medians of the differences were computed: the scores of the two operated groups were about equally impaired at the first posttest, but the two control groups improved again at the second posttest. The severe and mild hypotension subgroups showed the same trends as before.

Flicker Fusion Rate. The results of this test did not point in any particular direction. However, the differences between the hypotensive and normotensive anesthesia groups were more often what was predicted than not, i. e. the hypotensive group showed a greater drop in the threshold value than the normotensive group. The unoperated group showed a lowered fusion rate throughout (table 5, fig. 8–9).

No distinct difference emerged between the cases of severe and mild hypotension, though the threshold dropped more often in the severe than the mild cases.

The over-all differences were consistently significant, but this was because of the difference between the unoperated and the operated subjects. The differences between the cases of severe and mild hypotension were not significant as a rule.

Serial Tone-Length Judgment. The unoperated subjects showed practically no change from pretest to posttest scores. The two

operated groups had worse scores in the posttests; the normotensive group showed greater impairment than the hypotension group at the first test, but the situation was reversed at the second posttest. (Table 5, fig. 10.) As it was predicted, the severe hypotension subgroup showed greater impairment at both posttests than the cases of milder hypotension. None of the differences were significant.

The normotensive anesthesia subjects did slightly worse than the other two groups on every occasion, the unoperated subjects consistently best (table 4).

Color-Word Interference Test. The unoperated subjects' scores for the subtest A improved steadily from examination to examination. The normotensive group showed little impairment postoperatively, but the hypotensive group did worse at the first posttest than in the pretests, and it did not regain its pretest level at the second posttest (table 5, fig. 11).

The cases of severe and mild hypotension differed as predicted. There was significant over-all difference between the groups at the first posttest and also between the cases of severe and mild hypotension, P amounting to 0.03 for the first pretest, and 0.01 for the second.

The normotensive anesthesia subjects had slightly worse scores than the other subjects at every test. The hypotensive and unoperated groups performed at about the same level (table 4).

The scores for the subtest B showed that the unoperated subjects improved steadily from test to test. The operated subjects' scores deteriorated at the first posttest, the hypotensive group's slightly more than the other's. The gap between these two groups widened still further at the second posttest (table 5, fig. 12).

The cases of mild and severe hypotension differed as predicted, but not to a significant degree.

The normotensive anesthesia subjects had worse scores than the other groups throughout the tests, while the hypotensive and unoperated group performed at a similar level (table 4).

No systematic tendency could be discerned in the scores for the subtest C. No significant differences were forthcoming. The normotensive anesthesia subjects did worse in the pretests (table 4, 5, fig. 13.)

SRB Test. All three groups had approximately equal mean scores on the SRB test. The distribution of the IQ's is seen from table 2.

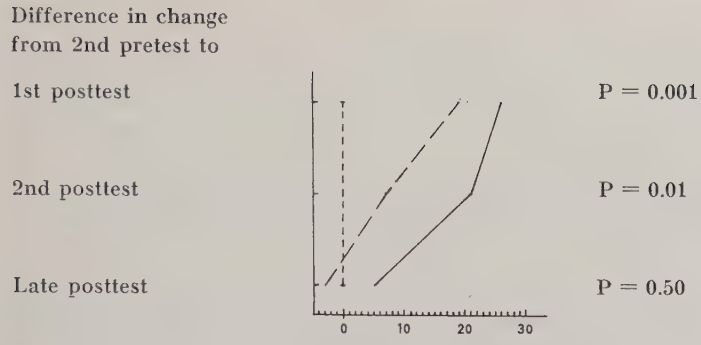

Fig. 14. Differences between operated groups and unoperated group in combined scores for all tests (table 3). Groups are represented by the rank means of their changes. Hypotensive anesthesia group ———; normotensive anesthesia group — — —; unoperated group ---------.

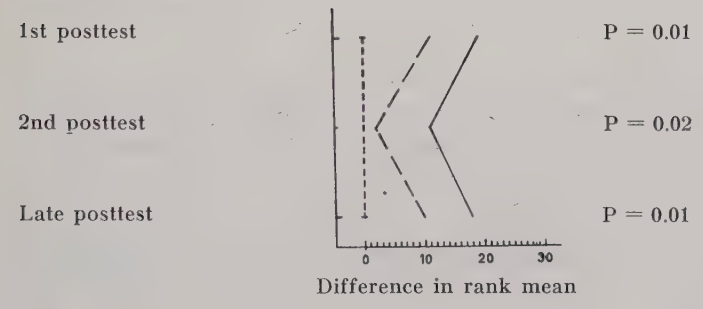

Fig. 15. Differences between operated groups and unoperated group in combined scores for choice reaction time, finger dexterity (2), mirror tracing (total time) and identical forms (table 3). Groups are represented by the rank means of their changes. Hypotensive anesthesia group ———; normotensive anesthesia group — — —; unoperated group ---------.

Late Posttests

The long-term effects of the hypotension on the psychometric scores had to be judged mainly from the differences between the two operated groups, as the unoperated group had by then been reduced to 12 subjects (p. 18).

General

Generally speaking, the performance level of all the groups returned after the year's interval to what it was before the operation, as a rule nearer to the scores at the second pretest than at the first. The normotensive anesthesia group continued to perform at a lower level than the others in most instances. Thus the psychometric tests at this stage did not point to any *gross* functional disorder.

However, the groups continued to differ in changes from the pretest level. When all the changes in scores from the second pretest to the late posttest were added together, the hypotensive group exhibited greater impairment or less improvement than the normotensive group. The difference was not significant, however ($P = 0.08$, table 3, fig. 14). Nor was the difference between the normotensive anesthesia and unoperated group significant in this respect; in fact the unoperated control group exhibited slightly worse figures than the operated control group.

The hypotensive anesthesia group showed significantly greater impairment or less improvement than the normotensive anesthesia group in several combinations of tests, e. g., finger dexterity (2) + choice reaction time ($P = 0.05$), choice reaction time + identical forms ($P = 0.02$), mirror tracing, total time + error time ($P = 0.03$), and in all single tests except flicker fusion rate, serial tone-length judgment and simple reaction time ($P = 0.04$).

Combining the scores for choice reaction time, finger dexterity (2), identical forms and mirror tracing (total time),—a combination also tried out for the immediate posttests,—showed significantly less improvement or greater impairment in the hypotensive anesthesia group than in the normotensive anesthesia group (table 3, fig. 15).

The same was true of the individual tests. Thus the hypotensive group showed larger negative or smaller positive changes in 6 of the 7 tests. The figures for the unoperated control subjects were often worse than those for the operated control subjects, occasionally worse than for the experimental subjects, but on the whole the unoperated group showed no decided tendency of any kind.

The cases of severe hypotension showed a greater impairment than the cases of mild hypotension in six variables while the mild hypotension group was worse in seven variables. However,

none of the differences between these two subgroups were significant.

Individual Tests

Accordingly, the same was true at the late post-examination as at the immediate, that the tests which differentiated most between the groups were the ones calling upon motor functions and mental speed and flexibility (mirror tracing, identical forms, choice reaction time, finger dexterity).

Simple Reaction Time. All the groups had a slightly longer simple reaction time at the posttest than at the pretests; the hypotensive anesthesia subjects were a little better at this occasion than the two control groups, who then performed at about the same level (table 4). As for the changes in the scores, the groups differed in the reverse order to what they had done before, the unoperated control group showing the largest impairment from the second pretest to the late posttest and the hypotensive anesthesia group the smallest (table 5 and fig. 1).

Choice Reaction Time. The hypotensive anesthesia group performed about the same as the unoperated group and the normotensive group slightly worse than the other two. All groups returned to the second pretest level (table 4). As for the score shifts, the groups differed in the same way and to the same extent as in the changes from pretests to immediate posttest scores; in other words, the hypotensive group showed the worst figures (table 5 and fig. 2).

Finger Dexterity. The hypotensive group performed better in this test on this occasion than the other two groups, the same as it did in the immediate posttests, and the control groups worse, at about the same level as they did at the second posttest (table 4). As for the change from the second pretest to the late posttest, the figures for the hypotensive group were worse than for the other two groups; the figures for the unoperated subjects were surprisingly poor in this respect (table 5, fig. 3–4).

Mirror Tracing. All the groups did better on this this test than they had at the pretests, the unoperated group better than the others, the same as in the immediate posttests (table 4). As for the changes

from pretest to late posttest, the hypotensive anesthesia group showed significantly less improvement than the normotensive anesthesia group for total time ($P = 0.05$), but not significantly less for error time ($P = 0.07$, table 5, fig. 5–6).

Identical Forms. The unoperated control group did better on this test than the other two operated groups, who performed at about the same level. All the groups performed at the same level as they had at the second pretest (table 4). As for the changes from the scores at the pretests, they were about the same as at the immediate posttests, the hypotensive anesthesia group having worse figures than the others (table 5, fig. 7).

Flicker Fusion Rate. Both operated groups did worse at this test than the unoperated group, the hypotensive anesthesia group the worst (table 4). The changes in the scores from the pretests showed no distinct tendency of any kind; the figures for the hypotensive group were somewhat worse than the others in the ascending series, but the conditions were reversed in the descending series (table 5, fig. 8–9).

Serial Tone-Length Judgment. The hypotensive group's scores for this test were better than those of the two control groups, which performed much alike. All the groups performed at about the same level as at the pretests (table 4). Analysis of the changes in the scores from the pretests revealed the opposite conditions to those prevailing at the immediate posttests, i. e., both operated groups had improved at the late posttest, the hypotensive group most, while the unoperated group's scores had deteriorated (table 5, fig. 10). The hypotensive and normotensive anesthesia groups differed significantly in this respect ($P = 0.03$).

Color-Word Interference Test. The unoperated subjects had the worst scores and the hypotensive anesthesia subjects the best. All three groups performed at about the same level as they had at the pretests (table 4). The changes revealed that both operated groups had improved since the second pretest, the hypotensive anesthesia group a little less than the normotensive group. The scores for the unoperated control group had deteriorated in comparison with those at the second pretest (table 5, fig 11–13).

INFLUENCE OF OTHER FACTORS THAN HYPOTENSION ON INTERGROUP DIFFERENCES

Analgesics. The effect of analgesics was roughly quantified in 15 of the hypotensive anesthesia group and 13 of the normotensive anesthesia group (p. 68). Data about the use of these drugs could only be obtained for 4 of the unoperated cases, and so it is impossible to compare this group with the others.

At the time of the pretests, most of the hypotensive anesthesia group, 11 out of 15, were unaffected by analgesics, 3 were moderately affected and 2 strongly so. The normotensive group was distributed more evenly, 4 out of 13 unaffected, 7 moderately affected and 2 strongly affected.

It was about the same at the posttests. Half of the hypotension group, 8 out of 15, were unaffected at the first posttest, half moderately affected. The majority of the operated control group, 9 out of 13, were moderately affected, 2 were strongly affected and 2 were unaffected. The conditions were about the same at the second posttest.

Testing with the Mann–Whitney and Kruskal–Wallis methods showed a consistently greater analgesic effect in the operated control group, both before and after operation. However, on no occasion did it differ significantly from the experimental group in this respect.

Rank correlations between the amount of analgesics and the performance in the separate tests showed no noteworthy connection in the majority of cases. Significant correlations were observed, however, for flicker fusion rate, mirror tracing and serial tone-length judgment, the coefficients amounting to about 0.40. Adding the scores in the second and third of these tests gave a coefficient of nearly 0.80. It would seem, therefore, that the scores were affected by analgesics, at any rate in the sample analyzed. As far as can be judged, this would mean that the scores of the normotensive anesthesia group would be most affected by analgesics, and this should tend to reduce the differences between the hypotensive and normotensive anesthesia series. The probabilities are that the changes in scores were not affected on the whole by analgesics, which operated equally on the pretest and posttest scores. The greater analgesic effect in the normotensive group is in accordance with their consistently worse absolute scores in most of the tests.

Myelography. Analysis was done to see whether the scores could

have been affected by myelographic examinations. Myelographic examination was done one or two days before the second pretest in 5 subjects in each of the hypotensive and normotensive group. It was done three or four days before the second pretest in 6 of the hypotensive and 7 of the normotensive group. It was done five or six days before in 2 cases of each of these groups. It was done more than a week before in 8 of the first and 3 of the second group. The same form of examination was done one or two days before the second pretest in 4 of the unoperated cases, three or four days before in 1 case, five or six days before in 1 case and more than a week before in 1 case.

It was done after the second pretest in 5 of the hypotensive anesthesia group, 10 of the normotensive group and 12 of the unoperated subjects (two of which after both immediate posttests).

In other words the three groups were treated much alike with regard to myelography before the second pretest. The difference between them in the number of these examinations more than a week before probably does not affect the comparison of their psychometric scores. The difference of note in this connection lies in the greater number of myelographic examinations after the second pretest in the two control groups than in the hypotensive anesthesia group. This would mean that the normotensive subjects were often under greater strain (operation and myelography) than the other operated subjects at the first posttest, and it is reasonable to assume that this would tend to cause a greater impairment in the posttest scores in this group. In the unoperated control group moreover, the myelographic examinations between the first pretest and second posttest probably tended to reduce the practice effect at the posttests. Both these circumstances would, if anything, tend to reduce the differences between the experimental and control groups.

Extent of Operation. More than one intervertebral space was exposed in 7 cases in the hypotensive group as opposed to only 1 case in the normotensive group. Accordingly, the groups were not exactly alike in this respect. Most of these 8 subjects showed greater than median impairment in the combined scores (all test variables and four-test combination) at the immediate posttests. At the late posttests, however, their scores were no worse than those of the others. While the immediate posttest inferiority associated with extensive operation may have helped to cause the inferiority of the hypo-

tensive to the normotensive group, it can hardly explain the whole difference observed between the groups. However, it is impossible to say how much of the inferiority in the 7 hypotensive cases with an extensive operation was due to the hypotensive anesthesia and how much to the operation being of large extent.

Most of the hypotensive cases with this complication belonged to the severe hypotension category.

Hemorrhage. A large hemorrhage occurred in 1 of the hypotensive anesthesia cases (case 31) and a moderate loss of blood was noted in 4 cases of both the hypotensive and normotensive anesthesia group. Thus the groups were much the same in this respect. However, the cases of hypotension and hemorrhage had much worse combined scores (all test variables and four-test combination) than the cases of normotension and hemorrhage on all testing occasions. This would indicate that a combination of hypotension and hemorrhage led to greater impairment in scores than hemorrhage and normotension. It may have been, accordingly, that the cases of hemorrhage in the hypotensive anesthesia group helped to cause the inferior scores in this group as compared with the normotensive group. It is hardly possible, however, to ascribe the inferiority in this group solely to some of its subjects having lost a considerable amount of blood.

Two of the hemorrhage cases (25 and 31) were also complicated by an unusually extensive operation. Four out of the 5 hypotensive cases with hemorrhage belonged to the severe hypotension group.

Dural Lesion. The dura was injured during the operation in 3 of the normotensive anesthesia subjects, but in none of the hypotensive subjects. One of the 3 normotensive subjects had a subaverage combined score for all the tests and for the four-test combination. The only way this could have influenced the difference between the groups, if at all, would have been to have reduced the gap between the two operated groups.

Deviations from Testing Timetable. Sometimes it was impossible to keep to the timetable decided upon.

The second pretests were given between 1 and 3 days before operation, or much as planned, in 25 of the hypotensive anesthesia

cases and 23 of the normotensive cases. A longer time than intended elapsed before operation in 3 of the hypotensive cases (6, 7 and 10 days) and 5 of the normotensive cases (5, 6, 6, 7 and 8 days).

The first posttests were given between 4 and 7 days after the second pretest, or much as planned, in 26 of the hypotensive anesthesia cases, and 25 of the normotensive anesthesia cases. A longer time than intended elapsed between these two examinations in 2 cases in the hypotensive group (10 and 14 days) and in 3 cases in the normotensive group (11 to 16 days). Four to 6 days, or much as planned, elapsed in 13 of the unoperated cases, and a shorter time than intended in the 6 remaining cases (2 or 3 days).

The second posttests were given between 5 and 8 days, or much as planned, in 20 of the hypotensive cases, in 22 of the normotensive cases, and in all 13 unoperated cases. A longer time than planned elapsed in 4 of each of the two operated groups (between 10 and 17 days).

Accordingly, all the intervals between the various stages in the timetable were longer than intended for some cases in both the hypotensive and normotensive group, but the two groups did not differ in this respect. In the unoperated group, the tendency was more to a shorter time than intended. The small differences between the groups in this respect had probably nothing to do with the differences between them in psychometric results.

Errors in Psychometric Scores. The scores for the subjects in this study may have been influenced by several factors, e. g., pain, mental tension, the effects of medicine and myelography, amount of motivation to cooperate, and primary individual differences in the capacities measured. It was probably influence of such factors that caused the fairly wide dispersion of the scores. Though this means some uncertainty in the results, the study was designed so as to have these factors operate to an equal extent in all three groups. How well we succeeded in doing so is impossible to establish, but the analyses that were made did not reveal any systematic differences, except in hypotension, between the groups which might explain the greater impairment in the hypotensive cases. All the comparisons with the unoperated group, especially for results at the late posttesting, should be made with caution for this group was not fully comparable with the others in several respects, particularly not in size.

CHAPTER 5

Psychiatric Section. Pre-Appraisal and Immediate Post-Appraisal

by Mats Gruvstad

COLLECTION OF DATA FOR COMPARING GROUPS

Interview

Each of my three appraisals of the patients' psychiatric condition was based on the data I obtained during a personal interview. During these interviews I tried to keep to a consistent plan, so as to cover as much as possible data bearing on a number of psychiatric variables which I rated. However, I kept to an elastic schedule in my conversations with the patients, so as to be able to concentrate on any question of particular interest to the case on hand.

I began by asking them about the symptoms their back disease caused them at the time, and at any earlier date, and how they had benefited from any treatment they had had up to then. From the answers to these questions, and from the way they complained about their symptoms and how much analgesics they needed, I tried to determine how they reacted in general to their disease and what their attitude was to operation.

After obtaining this information, I told the patients that the reason we were examining them was that we wanted to know how tired people got after operations of the kind they were about to undergo, particularly how various forms of reacting were slowed down and how ability to concentrate was affected after the operation. Every one of the patients was told the same reason, though the way they were told was varied to suit the individual patient. I attempted to create a friendly atmosphere between us, and to make the patients want to cooperate in the rest of the study.

Independently of the examinations made by the staff at the orthopedic department, I gave the patients a physical and neurologic examination. After this, I took the psychiatric history, covering the family history, childhood environment, schooling and choice of vocation, vocational training, jobs held, adjustment to family life

and, lastly, any previous physical or mental ailments. While going through these aspects, I tried to elicit what the patients thought about their own personality, how they reacted to difficulty and adversity, how quick and alert they were, and how easy it was for them to change from one sort of manual or theoretical task to another. Any form of mental disorder they experienced then or in the past we discussed at length. However, I never attempted to force any confidences from a patient who obviously preferred to keep things to himself, or to pry into any subject on which he was particularly sensitive. As a rule, a complete past history could be obtained. About two hours were devoted to this interview.

As already mentioned, I returned to the patients four to seven days after operation, or after the corresponding interval in the unoperated cases. If they had been operated on, I began by asking them to describe the way in which their mental abilities returned after the anesthesia. If operation had not been performed, I asked them to tell me how they had been mentally since the time I last saw them. I also tried to learn how active they had all been in the interval, by asking them how much they had conversed with the other patients, how much they read, and how long they could keep their interest from flagging in a radio or television programme.

I also asked them how they had been physically since the time I last saw them, about their opinion on the immediate results of the operation, if there had been one, and their opinion about the surgical plans for the near future. Sometimes I used this as a starting point for a discussion to find out how much they were able to reason in the abstract, but mostly one of the points the patients had taken up in their history was used for this purpose.

Rating of Psychiatric Items

I chose five items with which to be able to assess changes in the patient's mental condition from a psychiatric rating scale elaborated by Sälde and Dureman in 1954 (cp. Malamud and Sands 1947, Reznikoff and Zeller 1957, Reznikoff and Toomey 1959). I rated these five items on the impressions I received at the actual interview, disregarding any information the patients had given me in these respects. These items seemed to me to be particularly suited to this study, as they covered some mental functions which are usually found to be deteriorated in mental abnormalities of supposedly organic nature, viz., rate and flexibility of thought processes, level of

consciousness, amount of mental energy and degree of spontaneous mental activity (Mayer–Gross et al. 1955, Noyes and Kolb 1960, Ebaugh and Tiffany Jr., Stevenson and Sheppe Jr. in American Handbook of Psychiatry, Arieti 1959). Cerebrolesional disorders are often described in terms of impairment in these functions (Lewis 1942, Goldstein 1948, 1949, Himwich 1951, Courville 1953 a, Dencker 1958, Müller 1956, Müller et al. 1958, Talland 1958, 1959, Talland and Miller 1959, Mayman and Gardner 1960, Russell and Smith 1961, Smith 1961).

In addition, I attempted to check whether the ratings of these five items might have been affected by physical and mental stress connected with the operation, by rating the items pain, tension and basic mood.

Items

Rate of Thought.—By rate of thought I mean the speed of thought processes within any one set of associations. I rated this item in order to try to detect impairment in mental functions commonly described as slowness, torpidity or retardation. Naturally, it is impossible to rate this quality without being influenced by how quickly the subject changes expression and moves, and how quickly he talks.

I rated this item on a 9-point continuum, with 1 to 3 denoting extreme slowness, 7 to 9 various degrees of unusual rapidity and 4 to 6 normal rates of thought.

Spontaneous Flexibility.—By spontaneous flexibility I mean the ability to shift from one train of thought to another, or the ability to shift between different associative sets. This ability probably covered in part some components of the more specific cognitive function others have called "spontaneous flexibility" (Payne, in Handbook of Abnormal Psychology, Eysenck 1961). When doing the rating, I did not concern myself particularly with the flexibility of conceptual functions in the sense of Goldstein (1948, 1949). However, my ratings of spontaneous flexibity probably included some aspects of the ability to shift from a concrete to an abstract attitude and of the ability to assume a mental set voluntarily, and impairment in these functions are probably reflected in impairment of the more unspecific quality of flexibility which I assessed.

Ratings of 1 to 3 were given for rigidity with decreasing orders of perseveration, 7 to 9 for maximum abilities to shift and 4 to 6 for ordinary flexibility.

Level of Wakefulness.—By rating the level of wakefulness I hoped to be able to detect disorders like clouding of consciousness or fluctuations in the level of consciousness and various degrees of distractibility and confusion.

Ratings of 1 to 3 were given for low levels of wakefulness, 4 to 6 for ordinary levels and 7 to 9 for great alertness.

Fatiguability.—By fatiguability I mean the power of sustained mental effort. Abnormal degrees of fatiguability are probably closely associated with the level of consciousness, but I rated the two qualities separately in order to get the most possible information on the patient's performance level.

Average degrees of fatiguability were rated between 4 and 6, unusually little propensity to fatigue between 7 and 9, and unusually great fatiguability between 1 and 3.

Degree of Initiative.—By degree of initiative I mean particularly the amount of spontaneous mental activity which is evidenced. This quality was rated in order to get another aspect on the conative functions than those assessed in the foregoing variable. It was also hoped that it would lead to detection of any signs of the passivity noted in connection with different forms of organic cerebral lesion.

The rating was based on the patient's ability to give a continuous and detailed account of his personal history, and his propensity to take up a subject for discussion of his own accord. Increasing degrees of passivity were rated 3 to 1, ordinary initiative between 4 and 6 and great initiative between 7 and 9.

Degree of Pain.—I rated the degree of pain from which the patient was suffering solely from the impression he gave me in this respect.

When the patient had no or slight pain, he was rated 1 to 3 for this item, and when he was greatly tormented by pain he was rated 7 to 9.

Level of Tension.—For the same reason as the degree of pain was rated, it was considered necessary to rate the amount of tension the patient was under. An average amount of tension was rated between 4 and 6, a relaxed attitude between 1 and 3, and increasing levels of tension up to distinct anxiety reactions between 7 and 9.

Mood.—The ratings of the other variables being also affected by the mood of the patient at the time, I also rated this variable. An

ordinary basic mood was rated between 4 and 6, despondency between 1 and 3 and lightness of mood up to hypomania between 7 and 9.

Procedure

Except for one case, I did all the ratings. I did not attempt to make precise definitions for each of the 9 scale intervals. For some items, for example, fatiguability and initiative, this might have led to more exact judgment, but for others, for example, rate of thought and spontaneous flexibility, it might have led to less precision if the scale intervals had been rigidly defined. Thus one of these descriptive statements might have denoted one degree of impairment in one person, and another degree in another. If the intervals had been exactly defined it would also have meant a certain amount of difference in quality between them (cp. Cronholm and Ottoson 1960). According to the usual practice, I assumed that the steps on the various scales were equidistant.

I did my best to judge each variable independently of the other, and concentrated primarily on measuring for the sake of detecting intraindividual changes from one occasion to another. The arithmetic differences, expressed in steps of the scale, between the ratings at different appraisals were used to denote the change from the one appraisal to the other. It was assumed that these differences were measurable on an ordinal scale. The statistical method for comparing the groups was chosen accordingly (see chapter 2).

The cases underlying the data for the changes from the pre-appraisal to the immediate post-appraisal included 26 of the 32 hypotensive anesthesia cases and 26 of the 39 normotensive cases taken up in table 1, and 12 unoperated cases (appendix). The hypotensive group consisted of 8 women and 18 men, the normotensive of 7 women and 19 men and the unoperated of 5 women and 7 men. The age in the corresponding groups ranged between 26 and 59 (average 41), 17 and 63 (average 38) and 21 and 57 (average 39), and the IQ's between 79 and 128 (average 104), 80 and 143 (average 103) and 85 and 127 (average 105).

FEATURES FOR WHICH GROUPS WERE COMPARED

Ratings

The ratings at the pre-appraisal for rate of thought, spontaneous flexibility, level of wakefulness, fatiguability and degree of initiative

in the individual cases are all given in table A in the appendix, which also shows the changes in the ratings at the immediate post-appraisal. The ratings for degree of pain, level of tension and mood are seen from table B in the appendix. In table 6 the three groups are compared for their *ratings* for the first five of these items at both of these appraisals, more exactly, the means and medians of their ratings are compared.

Table 6. *Psychiatric Ratings, Means and Medians of the Scores for the Different Variables in the Three Groups.*

Items		Pre-Appraisal		
		Hypotensive Anesthesia Group (N = 26)	Normotensive Anesthesia Group (N = 26)	Unoperated Group (N = 12)
Rate of thought	Mean	5.50	6.08	6.25
	Median	6.13	6.30	6.25
Flexibility	Mean	5.19	5.39	5.83
	Median	5.10	5.50	6.00
Wakefulness	Mean	5.77	6.00	6.75
	Median	5.94	6.33	6.83
Fatiguability	Mean	5.31	5.50	6.00
	Median	5.67	5.50	6.17
Initiative	Mean	5.04	5.31	4.58
	Median	5.00	5.50	4.90

Items		Immediate Post-Appraisal		
		Hypotensive Anesthesia Group (N = 26)	Normotensive Anesthesia Group (N = 26)	Unoperated Group (N = 12)
Rate of thought	Mean	4.54	5.35	5.83
	Median	4.50	5.50	5.75
Flexibility	Mean	4.04	4.62	5.50
	Median	4.00	4.63	5.50
Wakefulness	Mean	4.42	5.0	6.25
	Median	4.38	5.10	6.30
Fatiguability	Mean	4.27	4.77	4.92
	Median	4.50	4.64	5.00
Initiative	Mean	4.62	5.04	4.92
	Median	4.77	4.90	5.00

It is seen from this table that at the pre-appraisal all three groups had slightly more overaverage than underaverage ratings for all five variables. The inital values were slightly higher in the normotensive anesthesia and unoperated group than in the group undergoing hypotensive anesthesia, but the differences were small.

At the immediate post-appraisal, both operated groups showed lower ratings, on the average, than they had before, for all the items, and a much greater difference between the pre-appraisal and immediate post-appraisal ratings than the unoperated group.

The ratings are presented graphically in figure 16, where the medians of the operated groups in the five features are joined to make a composite profile. As seen, the narrow gaps between the groups at the pre-appraisal grew much wider at the post-appraisal, indicating a greater change in the rated items in the hypotensive anesthesia group than the normotensive group at the re-appraisal.

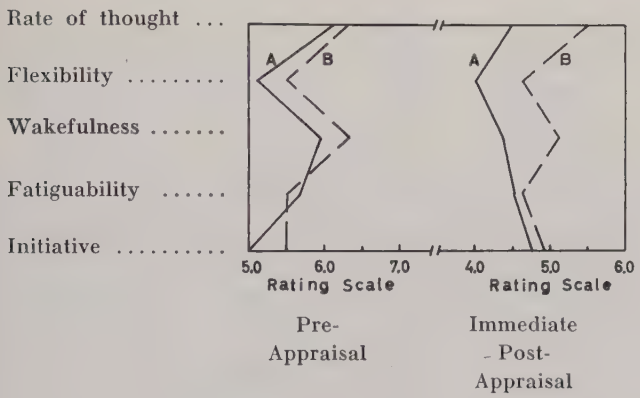

Fig. 16. The profiles formed by the medians of the ratings in the five psychiatric items in the two operated groups. A = hypotensive anesthesia group; B = normotensive anesthesia group.

Changes in Ratings from Pre-Appraisal to Immediate Post-Appraisal

All Groups.—Table 7 shows the average changes in ratings for the five first items from the pre-appraisal to the immediate post-appraisal in all three groups. Each item is analyzed separately. The groups are compared statistically by ranking all the differences in the individual item in all three groups in one series, with the largest

difference in the positive direction, or most improvement, rated as 1, and the largest difference in the opposite direction, or most impairment, rated the highest.

Table 7. *Psychiatric Ratings. Means, Medians and Rank Means of Differences in all three Groups between Ratings for five Psychiatric Variables at Pre-Appraisal and Immediate Post-Appraisal.*

Items		Hypotensive Anesthesia Group (N=26)	Normotensive Anesthesia Group (N=26)	Unoperated Group (N=12)	Significance of Differences between Groups (Kruskal-Wallis)
Rate of thought	Median diff. score	1.72	0.83	0.50	
	Mean diff. score	1.31	0.73	0.42	
	Mean of ranks	38.3	30.3	24.8	0.10—.05
Flexibility	Median diff. score	0.94	0.77	0.50	
	Mean diff. score	1.23	0.77	0.33	
	Mean of ranks	38.3	30.8	23.7	0.10—.05
Wakefulness	Median diff. score	1.68	0.90	0.25	
	Mean diff. score	1.35	1.0	0.42	
	Mean of ranks	38.8	31.3	21.5	**0.05—.02**
Fatigability	Median diff. score	1.17	0.79	0.30	
	Mean diff. score	1.12	0.73	0.67	
	Mean of ranks	34.5	31.7	29.8	0.80—.70
Initiative	Median diff. score	0.50	0.17	0.0	
	Mean diff. score	0.35	0.31	—0.17	
	Mean of ranks	34.4	32.9	27.6	0.70—.50

The hypotensive group showed a greater impairment in rate of thought, flexibility and wakefulness than the normotensive and unoperated group. The same was true, but not to the same extent, of

fatiguability. The unoperated group exhibited distinctly less impairment than the other two groups at the immediate re-appraisal in every respect, as demonstrated in figure 17.

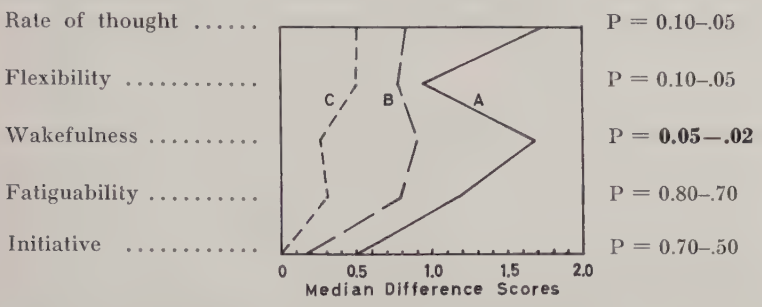

Fig. 17. The profiles formed by the median changes in ratings for the five psychiatric items from the pre-appraisal to the immediate post-appraisal in all three groups. A = hypotensive anesthesia group; B = normotensive anesthesia group; C = unoperated group.

Analysis by the Kruskal-Wallis method showed that the variance between the groups was only significant for wakefulness, P amounting to 0.05–0.10 for rate of thought and flexibility.

Hypotensive vs. Normotensive Anesthesia Groups.—Table 8 shows how the hypotensive and normotensive anesthesia groups compared in changes in ratings at the immediate post-appraisal. To get a better survey of the changes, the mean rank of the changes in each group is given for each item. This table shows that, as predicted, there was

Table 8. *Psychiatric Ratings. Changes in five Psychiatric Variables Noted at Immediate Postoperative Appraisal in Operated Groups.*

Items	Hypotensive Anesthesia Group (N = 26)	Normotensive Anesthesia Group (N = 26)	Significance of Differences between Groups (Mann–Whitney)
	Rank Means	Rank Means	
Rate of thought	29.9	23.2	0.06 **(0.05)**
Flexibility	29.5	23.5	0.08 (0.07)
Wakefulness	29.4	23.6	0.09 (0.08)
Fatiguability	27.8	25.3	0.28
Initiative	27.0	26.0	0.41

a greater impairment in the rate of thought, flexibility and wakefulness in the hypotensive anesthesia group than the other. Testing for significance with the Mann–Whitney *U* test showed that the impairment in rate of thought was significantly greater when correction was made for tied ranks, but not otherwise. Figures 18–21

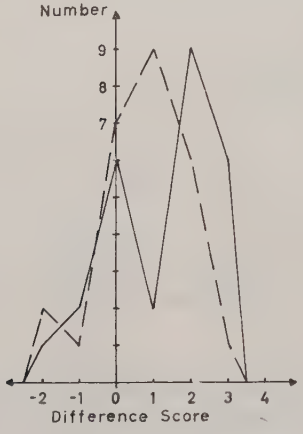

Fig. 18. Rate of thought.

Fig. 19. Flexibility.

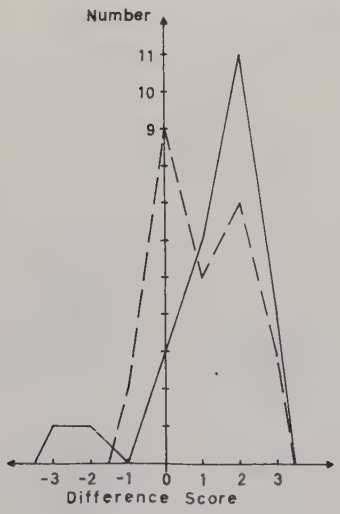

Fig. 20. Wakefulness.

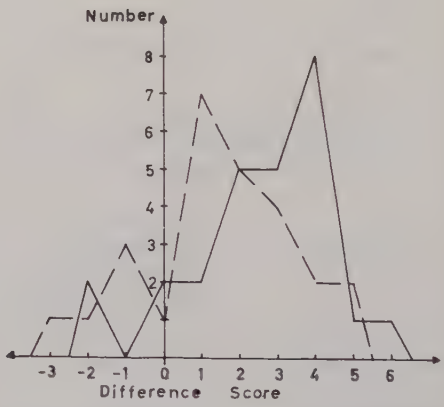

Fig. 21. Rate of thought + Flexibility.

Fig. 18–21. Distribution of individual differences from pre-appraisal to immediate post-appraisal in ratings for rate of thought, spontaneous flexibility, wakefulness, and rate of thought and flexibility combined. Hypotensive anesthesia group ———; normotensive anesthesia group — — — .

illustrate how the changes in rate of thought, flexibility and wakefulness were distributed in the two operated groups. They show a greater tendency in the hypotensive anesthesia group to larger impairment than in the normotensive group. It is also evident, however, that the distribution of the changes in the one group overlaps to a large extent that in the other.

When the changes in rate of thought and spontaneous flexibility are added together, a more distinct difference emerges between the distribution of the changes in the groups, as seen from figure 21. On the other hand, as evident from table 11, the ratings for rate of thought and flexibility are correlated to a certain extent, and the question is whether these two items were rated independently of one another. No attempt was made, therefore, to see if the groups differed significantly for the combined changes.

In summary, the results of these comparisons point to a greater impairment in the hypotensive anesthesia group than in the normotensive anesthesia group in rate of thought, flexibility and wakefulness.

Cases of Severe vs. Cases of Mild Hypotension.—The relationship was analyzed between the severity of the lowering of blood pressure, as judged from criteria I to III described in chapter 3, and the changes at the immediate post-appraisal. The impairment was often greater in the cases of severe hypotension than in the rest of the operated cases. Sometimes it was greater in the cases of severe hypotension than in the cases of mild hypotension but sometimes the situation was reversed.

INFLUENCE OF OTHER FACTORS THAN HYPOTENSION ON INTERGROUP DIFFERENCES

The differences between the changes in the unoperated group and the two operated groups were not of as great significance as the differences between the two operated groups, for it was known at the post-appraisal whether or not operation had been performed. Only the operated groups, therefore, will be considered in most of the following section on how the results may have been affected by factors other than hypotension.

Differences in Surgical and Anesthesiologic Conditions

Analgesics.—The nurses on duty in the wards were told that it was preferable not to give the patients any analgesics the day they were to undergo psychometric or psychiatric examination, but this could naturally not be avoided in some cases. We were able to obtain exact information on the amount of analgesics the patient received in 15 cases in the hypotensive anesthesia group and in 13 cases in the normotensive group.[1] Comparison between these cases revealed that slightly more analgesics had been given in the normotensive cases both at the pre-appraisal and immediate post-appraisal. However, the intergroup difference was the same from the one occasion to the other in this respect, and the separate groups did not differ from one occasion to the other. Consequently, it is unlikely that differences in the amount of analgesics given in the two groups had a material effect on the results of the comparison between them for the changes at the post-appraisal.

Myelography.—Myelograms were taken more than a week before the pre-appraisal in 6 hypotensive and 3 normotensive cases. This examination was made during the five days before the pre-appraisal in 15 of the hypotensive anesthesia group and 16 of the normotensive group, and the same day as the pre-appraisal or one of the two following days in 5 and 7 cases, respectively. Thus there was no systematic difference between the groups in this respect, and the results of the comparisons could hardly have been distorted by differences in intervals between myelography and psychiatric appraisal of the patient's mental state.

Premedication and Length of Anesthesia.—The same type and amount of premedication was given in both operated groups. They both got the same amount of pethidine during the operation, on the average. The trichlorethylene anesthesia was maintained for a slightly longer time, on the average, in the normotensive anesthesia group. If anything, this would have caused more impairment in the normotensive group, and so this source of error could not possibly explain why a greater impairment was noted in the hypotensive group.

[1] Unfortunately, the records concerning the administration of analgesics in 11 of the hypotensive and 13 of the normotensive cases were not available when information on this point was collected.

Table 9. *Psychiatric Ratings. Changes in Scores for five Psychiatric Variables Noted at Immediate Post-Appraisal of Cases of Complicated Operation. Mean Differences Compared with those of Entire Groups.*

	Case No.	Age Years	Rate of Thought	Flexibility	Wakefulness	Fatigability	Initiative
Hypotensive Anesthesia				*Arithmetic Differences*			
Extensive operation	10	36	3	0	1	2	1
	13	41	3	3	3	−2	−2
	17	30	2	0	1	2	1
	23	34	2	3	2	−1	1
	24	38	0	0	0	1	0
	25	49	0	2	2	2	2
Hemorrhage at operation	6	39	3	1	2	1	1
	19	36	1	1	1	3	1
	29	38	1	1	1	1	−1
				Mean Differences			
Complicated cases of hypotensive anesthesia (n = 9)			1.67	1.22	1.44	1.0	0.44
All cases of hypotensive anesthesia (N = 26)			1.31	1.23	1.35	1.12	0.35
Normotensive Anesthesia				*Arithmetic Differences*			
Extensive operation	37	43	1	0	0	2	1
	38	35	1	1	0	−3	0
Dural lesion at operation	36	19	1	0	2	0	0
	45	32	1	1	2	3	2
	53	53	0	1	0	0	−1
Hemorrhage at operation	57	36	2	2	2	3	3
	58	47	−2	0	0	−2	−3
				Mean Differences			
Complicated cases of normotensive anesthesia (n = 7)			0.57	0.71	0.86	0.43	0.29
All cases of normotensive anesthesia (N = 26)			0.73	0.77	1.0	0.73	0.31

Extent of Operation and Surgical Complications.—More than one intervertebral space was exposed in 6 of the hypotensive and 3 of the normotensive anesthesia group. Moderate hemorrhages (chapter 3) occurred in 4 cases in the hypotensive group and 3 of the normotensive. The dura was slightly injured in 2, possibly 3, of the patients given normotensive anesthesia. Accordingly, the two operated groups were not exactly alike in these three respects, all of which may have distorted the ratings to some degree.

Table 9 presents the changes at the immediate post-appraisal in the individual cases of large operation, moderate hemorrhage (excepting case 44) and dural lesion. The cases with these complications in the hypotensive group showed a slightly greater change in rate of thought, flexibility, wakefulness and fatiguability; con-

Table 10. *Psychiatric Ratings. Comparison between Uncomplicated Cases of Hypotensive and Normotensive Anesthesia in Changes in Scores for Psychiatric Variables at Immediate Postoperative Appraisal.*

Items		Hypotensive Anesthesia Group (n = 16, mean age = 40.8)	Normotensive Anesthesia Group (n = 16, mean age = 41.7)
Rate of thought	Mean diff. score	1.06	0.88
	Mean of rank	17.3	15.8
Flexibility	Mean diff. score	1.25	0.81
	Mean of rank	18.2	14.8
Wakefulness	Mean diff. score	1.19	1.13
	Mean of rank	17.3	15.8
Fatiguability	Mean diff. score	0.94	0.75
	Mean of rank	17.3	16.3
Initiative	Mean diff. score	0.25	0.44
	Mean rank	16.2	16.8

sequently, the possibility cannot be disregarded that these complications distorted the results as a whole. The effect of this bias is therefore subjected to special analysis in table 10.

In table 10 cases of extensive operation, moderate hemorrhage and dural lesion are excluded from both groups. In addition, 1 elderly patient was excluded from the hypotensive group and 3 young patients from the normotensive group, in order to get groups of the same size and age distribution.[2] The remaining 16 cases in each of the groups did not differ in length of anesthesia. As seen from this table, even when the groups were cut down in this way, the hypotensive group continued to show greater impairment in rate of thought and spontaneous flexibility. Although the differences were slight and nonsignificant, the persistence of the trend to greater impairment in the hypotensive group when the complicated cases were removed from it, would indicate that it was not the complications that caused the greater impairment in the entire group.

Difference in Interval between Operation and Immediate Post-Appraisal

The interval between operation and immediate post-appraisal was much longer than intended in 2 of the normotensive anesthesia cases—11 days in case 37 and 16 days in case 38. This could hardly have affected the results to any essential degree, and these two cases were included when the two groups were compared. However, they were excluded, for other reasons, when the uncomplicated cases of the two groups were compared.

Errors in Rating Procedure

Reliability.—The reliability of the rating scale used in the present study is not known. Furthermore, the intervals of the scales were not exactly defined. These deficiencies may have constituted important sources of error. If the reliability had been low, however, there would have been chance variations in both directions rather than the systematic differences that were observed. Furthermore, variables like the ones analyzed in routine clinical work were rated, and the rating was done regardless of the history or other outside information, and without knowledge of the form of anesthesia used. Thus

[2] Cases 6, 10, 12, 13, 17, 19, 23, 24, 25 and 29 were excluded from the hypotensive group and 36, 37, 38, 45, 48, 53, 56, 57, 58 and 59 from the normotensive group.

the differences observed between the two operated groups can hardly be referred to chance variations caused by low reliability.

Halo Effects.—It may have been that when I rated one item I was influenced by how I had rated another item. If there had been a large halo effect of this nature, there should be high correlations between the ratings for the different items.

Table 11 gives a list of the correlations between the ratings for the first five items at the pre-appraisal and immediate post-appraisal. All the data were included in this analysis, thus even from cases that were only examined once.

At the pre-appraisal, as seen from table 11, there were strong positive correlations between the ratings for rate of thought and flexibility, and between wakefulness and fatiguability. There were also positive correlations between the ratings for rate of thought and flexibility, on the one hand, and wakefulness, on the other, These correlations may have been due to a halo effect at the ratings or to an intrinsic connection between the faculties in question.

At the immediate post-appraisal, the correlations between all five items grew stronger. However, a distinct impairment was observed in the ratings of these items at the re-appraisal in the two operated groups, or the majority of all the cases rated, and it may have been

Table 11. *Psychiatric Ratings. Correlations between Ratings for the five Psychiatric Variables. All Subjects.*

	Rate of Thought	Flexibility	Wakefulness	Fatiguability	Initiative
Pre-Appraisal (N=84)					
Rate of Thought		0.66***	0.35***	—0.01	0.07
Flexibility			0.35***	0.06	0.04
Wakefulness				0.63***	0.23**
Fatiguability					0.24**
Immediate Post-Appraisal (N=68)					
Rate of Thought		0.58***	0.67***	0.46***	0.42***
Flexibility			0.55***	0.39***	0.28***
Wakefulness				0.68***	0.43***
Fatiguability					0.52***

* Significant at 5 per cent level of confidence
** " " 2 " " " " "
*** " " 1 " " " " "

this impairment which caused the stronger correlations between the ratings as a whole at the re-appraisal.

Preconceived Opinion on Outcome of Ratings.—It was anticipated that all the five traits measured would be impaired after the operation, i. e., that lower ratings would be noted. It may have been that this expectation affected the ratings. However, this would not explain that a larger impairment was noted in the hypotensive group than the normotensive group, unless the hypotensive group was superior in all five respects from the start. Perusal of table 6, however, reveals that the normotensive group had slightly higher ratings at the pre-appraisal. These slightly higher figures for the normotensive group at the pre-appraisal would, if anything, tend to reduce the intergroup difference in changes at the post-appraisal. In other words, it is unlikely that the systematic impairment observed in the hypotensive group at the immediate post-appraisal was due to a preconceived opinion on the outcome of the ratings.

Differences in Composition of Groups

If there were more mentally vulnerable individuals in one group than the other, this would have meant an important source of error. Judging from the records of the cases in question, this was not so. The two operated groups contained about the same number of instances of earlier mental disease, personality deviation or preoperative fear; the unoperated group contained relatively more. A history of head injury, infection with possible cerebral involvement, or verified cerebral lesion was equally common in both operated groups. If the mildest forms of personality deviation or social maladjustment are also taken to imply mental vulnerability, then the normotensive group contained more instances of mentally vulnerable persons than the hypotensive group. It is highly unlikely, therefore, that the greater impairment noted in the hypotensive group than the normotensive group was due to more mental vulnerability in the hypotensive group.

Differences in Pain, Tension and Mood at the Pre-Appraisal and in Changes in these Items at the Immediate Post-Appraisal

The individual ratings for pain, tension and mood are given in table B in the appendix.

The patients were often suffering from pain and tension when

I interviewed them, and this may have affected the ratings of the first five items. For this reason, the correlations between all eight items were calculated. The results are given in table C. (These correlations, like the ones given in table 11, are based on all the rating data, thus even from the cases that were only rated once.)

At the pre-appraisal, as seen from this table, the ratings for tension were negatively correlated with the ratings for fatiguability and initiative. At the immediate post-appraisal, the ratings for pain and tension were positively correlated, though slightly, with the amount of impairment in rate of thought, flexibility, wakefulness, fatiguability and initiative. The ratings for basic mood were negatively correlated with amount of impairment in all these five items. However, all the correlations were relatively small.

In table D in the appendix, finally, the three groups are compared for changes in pain, tension and mood at the immediate post-appraisal. In this table a positive value for the change denotes an improvement for pain and tension but an impairment for mood. The only change in which the two operated groups differed was in the change in tension, the normotensive group showing slightly greater improvement in this respect at the re-appraisal than the hypotensive group. This difference was not significant. The two operated groups showed greater improvement, on the average, than the unoperated group.

Seeing that the ratings of pain, tension and basic mood were only slightly correlated with the ratings for the other items, and that the two operated groups did not differ significantly in changes in pain, tension and mood, it seems unlikely that the differences between the operated groups in changes in rate of thought, flexibility and wakefulness were due to any essential degree to differences in pain, tension and basic mood.

CHAPTER 6

Psychiatric Section. Late Post-Appraisal

by Mats Gruvstad

SOURCES OF DATA FOR COMPARING GROUPS

Interview

The follow-up examination was usually made a year and a half after the hospital stay. The hypotensive anesthesia group was re-examined between 11 and 31 months after (25 months on the average), the normotensive anesthesia group between 5 and 28 months after (20 months on the average) and the unoperated group between 11 and 31 months after (22 months on the average). The patients came to the out-patient department for testing and interviewing.

The interview was carried out on informal lines, as when the patients were in the hospital. I began by asking the patients about their backs and, while we were on this subject, I tried to find out how long they had been unable to work after they left the hospital, what symptoms they had felt when they first came home, and when they went back to work, and if any symptoms that had vanished after the operation had come back. At the same time I tried to ascertain whether there had been any change in their work or earnings since their operation. From all this information, I assessed, firstly, whether their mental state had been affected by any persisting back trouble and, secondly, whether their working capacity had been altered after their operation. Sometimes the patients' situation in these respects had changed for reasons that were of no interest to this study, e. g., some married women had left gainful employment to devote themselves to their homes, and other patients had stopped working to take up studies, or because of some disease other than back trouble. When this had happened, I tried to get the patients to decide whether there were any reasons of mental nature for their having changed from the work they had done before. I also asked them whether they suffered after their hospital stay from headache, dizziness, sensory oversensitivity, or from difficulty in concentrating,

listlessness, difficulty in shifting from one train of thought to another, or impairment in memory. Finally, I asked for their opinion on the way they had been examined and treated in the orthopedic department, in the same way as at the pre-appraisal.

All the patients' mental symptoms, headache, dizziness and sensory or mental oversensitivity after hospitalization were noted, and special weight was placed on the troubles the patients reported of their own accord.

Rating of Psychiatric Items

For the third time ratings were made of five of the psychiatric items: rate of thought, spontaneous flexibility, level of wakefulness, fatiguability, and degree of initiative. The three variables, pain, tension and mood, were not rated consistently, however, for by this time most of the patients had recovered.

Overall Impression

In addition to rating psychiatric items, I tried to estimate the patients' mental state, with special reference to recent memory, power of concentration and propensity to get irritated, and looked particularly for changes in emotional or conative aspects, and signs of a more concrete attitude or other evidence of intellectual deterioration since the time I last saw them. From this estimation and from the patients' symptoms I tried to form an overall impression on whether they showed any change of lesional origin.

When making this condensed opinion, I paid no attention to whether the disorders the patients complained of or I noticed could have been caused by other circumstances than the operation and anesthesia. I only noted all the changes that could possibly be referable to a brain lesion, thus even ones that were probably caused by toxic action, senile lesions or other conditions leading to mental deterioration. I formed this overall impression before I went through any of the outside data.

Hospital Records and Registers of Sickness Insurance and Public Relief Bureaus

Data concerning the duration of incapacity for work and compensation class were obtained from the sickness insurance authorities, and other pertinent data from the social registers in the three cities in which most of the patients lived. The hospital records at

the orthopedic department were gone through and records from other hospitals were collected on the basis of information from the patients or elsewhere.

FEATURES FOR WHICH GROUPS WERE COMPARED

Canges in Ratings at Late Post-Appraisal From Immediate Post-Appraisal and Pre-Appraisal

Only the two operated groups were compared statistically for the changes in the ratings of the five psychiatric items at the late post-appraisal.

An analysis of the changes in the five items from the immediate to the late post-appraisal disclosed a greater improvement on the average in the hypotensive than in the normotensive group in all five items. However, the groups did not differ significantly in any way, as seen from table 12.

Table 12. *Psychiatric Ratings. Changes in five Psychiatric Variables from Immediate to Late Post-Appraisal in Operated Groups.*

Items		Hypotensive Anesthesia Group (n = 26)	Normotensive Anesthesia Group (n = 25)	Significance of Differences between Groups (Mann-Whitney two-tailed tests)
Rate of thought	Mean	— 1.50	— 0.84	
	Median	— 1.61	— 0.81	
	Mean rank	22.4	29.8	0.08
Flexibility	Mean	— 1.23	— 0.96	
	Median	— 1.05	— 0.87	
	Mean rank	24.5	27.6	0.46
Wakefulness	Mean	— 1.31	— 1.08	
	Median	— 1.39	— 1.19	
	Mean rank	24.8	27.3	0.56
Fatiguability	Mean	— 1.50	— 1.20	
	Median	— 1.72	— 1.25	
	Mean rank	24.3	27.8	0.40
Initiative	Mean	— 0.81	— 0.16	
	Median	— 1.06	— 0.05	
	Mean rank	22.2	30.0	0.06

Table 13 shows the changes in the five items from the pre-appraisal to the late post-appraisal in the two operated groups. (The changes in the individual cases can be seen from table A in the appendix.) It is evident from table 13 that there was little change

from the pre-appraisal, if any, in either group in rate of thought, flexibility, wakefulness and fatiguability.

The hypotensive group showed less improvement than the normotensive group in flexibility, but this difference was not significant. It showed greater improvement than the normotensive group in rate of thought, wakefulness and fatiguability, but nor were these differences significant (this time as judged by the two-tailed test).

In initiative the hypotensive group showed a greater improvement than in the other items, while the normotensive group showed a slight impairment; here the two groups differed significantly, again as shown by the two-tailed test.

It would seem, accordingly, that the differences between the two groups at the immediate post-appraisal were evened out at the late post-appraisal.

Table 13. *Psychiatric Ratings. Changes Noted at Late Post-Appraisal in Operated Groups. Differences between the Groups.*

Items		Hypotensive Anesthesia Group (n = 26, mean age = 43)	Normotensive Anesthesia Group (n = 33, mean age = 41)	P
Rate of thought	Mean diff. Score	—0.19	0.0	
	Median diff. Score	—0.14	0.0	
	Mean rank	28.1	31.5	0.45
Flexibility	Mean diff. Score	—0.04	—0.18	
	Median diff. Score	0.17	0.0	
	Mean rank	31.1	29.1	0.33
Wakefulness	Mean diff. Score	—0.08	0.09	
	Median diff. Score	—0.1	0.11	
	Mean rank	28.1	31.5	0.45
Fatiguability	Mean diff. Score	—0.39	—0.06	
	Median diff. Score	—0.1	—0.2	
	Mean rank	29.3	30.5	0.79
Initiative	Mean diff. Score	—0.62	0.15	
	Median diff. Score	—0.79	—0.11	
	Mean rank	24.7	34.2	**0.04**

Postoperative Symptoms

Many patients in all three groups said that they suffered from slight headache, dizziness and mental ailments during the first week after operation, or during the corresponding length of time in the unoperated cases. Symptoms of this kind are not mentioned in the case reports in the appendix, therefore, unless they lasted more than a week, or were unusually severe. Sensory oversensitivity was excepted from this rule, however, as it occurred slightly more often among the hypotensive cases.

Table 14 gives a survey of the subjective symptoms. In the first part of this table the two operated groups are compared for the frequency of symptoms on the whole, regardless of intensity or duration. As evident there, the two groups did not differ in this respect.

Table 14. *Complaints of Headache, Dizziness and Mental Impairment at Immediate and Late Post-Appraisal.*

	Hypotensive Anesthesia Group (N=30)		Normotensive Anesthesia Group (N=34)		Unoperated Group (N=19)	
	No.	%	No.	%	No.	%
Symptoms lasting from one day to one month						
Headache	4	13	7	21	—	—
Dizziness	8	27	9	27	—	—
Sensory oversensitivity	9	30	7	21	—	—
Slowness	11	37	16	47	—	—
Impaired ability to comprehend and concentrate	12	40	21	62	—	—
Forgetfulness	3	10	7	21	—	—
Symptoms lasting two or more months						
Headache } Dizziness	4	13	6	18	3	16
Mental complaints	8	27	12	35	5	26
Symptoms still present at late post-appraisal						
Headache } Dizziness	3	10	2	6	3	16
Mental complaints	5	17	9	27	7	37

Lasting about two Months or more

The second section of table 14 takes up the symptoms lasting for about two months or more. As seen there, headache and/or dizziness for this length of time occurred almost equally often in both operated groups, and also in the unoperated group. The same was true of mental disorders, such as lethargy, impaired ability to comprehend and concentrate, and forgetfulness.

From this it would seem that the hypotensive anesthesia did not lead to subjective ill-being during the first few months after operation more often than did the normotensive anesthesia.

Two cases who were excluded when the groups were compared, one from the hypotensive and the other from the normotensive group, will now be described in detail.

CASE 31. Female officeworker, aged 40, with mild psychasthenic traits, formerly healthy.

Unilaternal exposure was done of L4–S1 under trilene anesthesia for 50 minutes combined with 390 mg. of trimethaphan. The lowest B. P. noted was 40 mm.; the hypotensive area measured 1,640 mm^2. A profuse hemorrhage occurred during the operation, it being estimated that she lost about 2,800 ml. of blood, probably because the frame was not properly placed.

Afterwards she could remember periods of the time she was coming out of the anesthesia, but she was muddled and confused the first day after the operation. The next five days, she was unable to concentrate; she felt lethargic and dull, as if she had regressed to a lower level. At the immediate post-appraisal, she gave the impression of slowness, rigidity, increased fatiguability and apathetical gaiety.

At the late post-appraisal, she said that she had felt extremely tired the first four months after her operation, that she did not see as well as before, and that she had difficulty in understanding what she read or heard. At the same time she felt depressed and weepy, she slept badly, and she still had the feeling that she had deteriorated intellectually.

Fourteen months after the first operation at which time lumbosacral osteosynthesis was done, she was recovered mentally. The operation was not complicated, and it was not followed by any untoward mental effects. After sickness absence of 264 days, she felt quite recovered.

At the time of the late post-appraisal she had been back at work for three months. She then showed no distinct ill-effects from her operations.

The patient was not given the full battery of psychometric tests. The ones that were given showed no distinct changes between preoperative and postoperative scores, either immediate or late, but she scored worse in the post-tests than other subjects who had been operated on under hypotensive anesthesia.

CASE 71. A housewife of 37, formerly healthy.

Trichlorethylene anesthesia was maintained for 105 minutes; 25 mg. of pethidine were given. Unilateral exposure was done of L4–5. The patient lost

1,500 ml. of blood in a venous hemorrhage, and the loss was not substituted for entirely until after the operation.

The patient could only remember parts of the two days after operation. She also complained of listlessness and difficulty in concentrating, and said that she could not grasp what was said—"They ask too many questions. I can't keep up yet." (five days after operation). She was pale and enervated, showed rigidity of associations, and reduced tempo and wakefulness at the immediate post-appraisal. She was judged to be suffering from an organic lesion.

She showed no residual effects at the late post-appraisal. She said that the first four months after operation she could stand very little strain, but that after she recovered fully in mental respects. She was declared unfit for work for 171 days.

The psychometric testing showed a moderate impairment in scores compared with the rest of the normotensive anesthesia group in the 1st and 2nd post-tests, but less recovery at the late posttests than the other patients in the same group.

Both these patients, who had a severe hemorrhage during their operation, suffered from mental disorders for a long time afterwards. The impression is received when the two case reports are compared that the longer period of inability to work in case 31 might have been caused by the combination of the hypotension and hemorrhage. It is impossible to draw any conclusions from this comparison, however. Both patients said that they were fully recovered at the time of the late post-appraisal.

Persisting at Late Post-Appraisal

Three patients in the hypotensive and 1 patient in the normotensive group suffered from headache and/or dizziness at the late post-appraisal. These symptoms were slightly more common in the unoperated group at this time (table 14).

Five of the hypotensive, 9 of the normotensive and 7 of the unoperated group complained of listlessness, difficulty in concentrating and defective recent memory. The higher frequency of these symptoms in the unoperated group may have been due to this group being biased from the psychiatric standpoint.

Overall Impression

As far as I could see personally, none of the hypotensive group had persisting defects in mental functions at the late post-appraisal. The unoperated group showed more defects at this time than the operated groups, and the normotensive more than the hypotensive group.

No account will be given of my ratings on this point in the separate cases and groups. My intention with rating this opinion was only to

compare groups with respect to the vague, overall impression the individuals of the groups gave, an impression sometimes based mainly on events in the history of the patients, other times mainly on clinical observations. As this assessment was done before the social data were analyzed, it does not correspond to the usual diagnosis made in the clinic. Moreover, it probably placed too much weight on changes which presumably had nothing to do with the hypotension.

Hospital Records

The hospital records of the patients were gone through to check my opinion on the mental state at the pre-appraisal. In one case (93) it was learned by this means that a patient had neglected to mention at the late post-appraisal that he had undergone out-patient psychiatric care since the hospital stay. Data were also obtained about social assistance some of the patients had obtained before their hospital stay. In addition, two hospital records gave information of essential interest to this study. These cases will now be presented in detail.

CASE 13. A farmhand and lumberman, aged 41, formerly healthy, had not been to work for seven months at the pre-appraisal because of back pain. Apart from this he felt healthy and when he was examined at the orthopedic department he said he had nothing else wrong with him except his back. He seemed to be in good general condition, no abnormality was found in his heart and his blood pressure amounted to 135/90 mm. Hg. Otherwise there were no physical or neurologic signs of note.

On psychiatric examination, he seemed to suffer greatly from pain and preoperative fear, perhaps because he himself had insisted on having an operation.

The anesthesiologic and surgical data are seen from the appendix.

At the immediate post-appraisal the patient complained of listlessness, difficulty in concentrating and sensory oversensitivity, and the psychiatric ratings pointed to distinct mental defects. He had great difficulty in shifting from one train of thought to another, showed a reduced level of wakefulness and retarded rate of thought. He was tense and despondent, and it was concluded that he suffered from an anxiety reaction, possibly of lesional origin.

After operation, the patient was unfit for work for 130 days, and then returned to full-time work in the forests. Nineteen months after his operation he was again hospitalized because of a recurrence of his back trouble. After discharge he went back to work.

Some time after his operation, probably after a long interval, he began to suffer from a feeling of pressure and pain in the supraorbital region. Twenty-two months after his operation he was suddenly overcome one morning by vertigo, combined with nausea and clammy perspiration, which lasted for three hours. Another day at the same time he got a sudden attack of pricking in the precordial region and pain radiating out into his left arm. This attack was

followed by several others of the same kind during the next two weeks but on examination four or five weeks after the first attack he only complained of cough and shortness of breath. Examination revealed a good general condition, a sedimentation rate of 3 mm., nothing abnormal in the heart and lungs, and a blood pressure of 130/85; roentgen examination of the chest showed the heart to have a normal configuration, with a relative volume of 350 ml. per $m.^2$ body surface, and a suggested increase in the width of the thoracic aorta, but otherwise normal conditions. The electrocardiogram at rest was normal, but unfortunately no exercise record was taken. The patient's ailments, including the dyspnea, were concluded to be due to chronic bronchitis. Ten days after the first examination, the vital capacity was found to be normal, and the diagnosis of chronic bronchitis and "pectoral myalgia" was made.

The late post-appraisal was made 31 months after the operation. The patient complained on this occasion that his back still troubled him and that he was short of breath, but he said nothing about any heart trouble; he said that he was considering training for another kind of work, as lumbering was too hard on his back. He also complained of listlessness, impaired ability to concentrate and sensory oversensitivity.

Thirty-six months after operation the patient returned home from the forest one day, complaining of pain in his heart, and died a few hours later from coronary thrombosis. No autopsy was made.

It may have been that the patient had his heart disease at the time of the pre-appraisal, and it is not impossible that the hypotension reduced the coronary circulation, giving rise to a thrombosis which passed over unnoticed. He did not complain of anything that might point to a heart disorder either before or after the operation, however, and the history and observations indicate that the first thrombosis occurred long after the operation.

After the late post-appraisal, one of the patients in the hypotensive group was operated on for brain tumor.

CASE 34. A salesman of 45, earlier healthy. No neurologic or psychiatric examination was made prior to operation.

Trichlorethylene anesthesia was maintained for 60 minutes; 175 mg. of trimethaphan were given, reducing the blood pressure to at the lowest 65 mm., and causing a hypotensive area of 200 mm^2. Unilateral exposure of L4–5 was done. No complications occurred.

At the immediate psychiatric post-appraisal, the patient complained of brief episodes of severe headache after the operation. No distinct signs of changes in mental functioning were observed at this interview.

Despite an infection in the wound after he returned home, the patient felt quite recovered mentally six weeks later. However, he continued to have back trouble, and seven months later lumbosacral osteosynthesis was performed. There were no surgical postoperative complications. However, he noticed that a form of bitemporal headache he had had for several years grew worse after the operation, and that afterwards he also felt listless and despondent, had

difficulty in grasping intellectually, had a worse recent memory and was prone to tears.

At the late post-appraisal three months after the second operation, no distinct disorders could be noted. Four weeks earlier, however, focal epileptic attacks had set in, and his headache had begun to trouble him more. Nine months after the late post-appraisal, a frontotemporal astrocytoma (type I) was excised in part.

Psychiatric examination had not revealed any definite change in personality, but the psychometric tests showed a marked over-all impairment in mental functions in comparison with the rest of the hypotensive anesthesia group already after the first operation. The late posttests revealed a more pronounced reduction in performance in several tests than in the immediate posttest.

It is hard to form an opinion about this case, just as it was about case 13 because the patient had undergone two orthopedic operations and for that reason could not be compared with the others. Nor was it possible to say how much the psychiatric observations that were made were referable to the tumor; he showed no definite physical or mental evidence of tumor either time I examined him after the operation, though the growth was probably present at the time. The psychometric testing, however, revealed distinct functional impairment at the immediate posttests. Even at the late post-appraisal I detected no unequivocal signs of neuropsychiatric defect, but the psychometric tests revealed distinct functional disorders. The patient was not given a thorough neurologic examination, as the first neuroradiologic examination had recently been done with negative results. This patient was excluded when I compared the groups for changes in the ratings.

Sickness Compensation

In table 15, the groups are compared for the length of time they were pronounced unfit for work. The two operated groups were declared incapable of work for a longer time, on the average, than the unoperated group. The hypotensive and normotensive groups did not differ in this respect, whether whole groups or matched groups were compared (table 10). The complicated operated cases were also compared with the other subjects in different ways; none of these comparisons revealed any difference in length of incapacity for work. Nor did any difference emerge when the men in the hypotensive and normotensive groups were compared. The greater mental impairment in the hypotensive group obviously did not cause longer incapacity for work.

Table 15. *Duration of Incapacity for Work in the Three Groups of Cases.*

Duration of Incapacity in Days	Total Series		
	Hypotensive Anesthesia Groups (N=30, Mean age=41.3)	Normotensive Anesthesia Groups (N=36, Mean age=38.2)	Unoperated Groups (N=22, Mean age=40.5)
Mean	**97**	**102**	**58**
Range	38—284	33—402	1—294

	Matched Groups	
	Hypotensive Anesthesia (N=16, Mean age=40.8)	Normotensive Anesthesia (N=16, Mean age=41.7)
Mean	**73**	**100**
Range	84—156	33—312

Under the Swedish system of insurance, a person is compensated for illness roughly according to the amount he earns, in other words, roughly according to his working capacity. People are divided into different compensation classes, as they are called. Analysis revealed that the groups in this series did not differ with regard to compensation class after the operation. Thus the mental disorders observed in the hypotensive group at the immediate post-appraisal apparently had no social consequences.

Public Relief

Perusal of the social registers in the three cities from which most of the subjects came revealed that some of them had received assistance from the authorities before they went to hospital. Some patients were registered at the Temperance Board. No patient had received assistance from public means after the operation for any reasons that could be traced to the hypotensive anesthesia.

In conclusion, while it may be argued that all the foregoing information allow only a rough estimate of the subjects' social condition, the results were all in agreement, and were also in agreement with the information I received from the patients themselves.

Effect of Other Factors than Hypotension on Postoperative Mental Symptoms and Length of Incapacity for Work

No orthopedic analysis was made of the material. The hypotensive and normotensive anesthesia groups showed the same amount of

persisting low back pain, and the frequency of postoperatively reduced capacity for work because of back trouble seemed to be about the same after both types of anesthesia as that observed by other authors (Söderberg and Sjöberg 1961).

Study of the relationship between mental vulnerability and postoperative mental disorders in the present series revealed the following: Assuming that the subjects who had had mental disease or difficulty in social adjustment before their operation (cp. Kozol 1945, Müller 1956), or who exhibited mild personality deviation, preoperative fear (Lindemann 1941), or both, were mentally vulnerable, there were 27 mentally vulnerable subjects in the two operated groups; these 27 were incapable of working for 108 days after operation, on the average, while the remaining 39 subjects were incapable of working for 96 days. This difference is not significant when tested by the Mann–Whitney *U* test.

Seventy-three per cent of the mentally vulnerable subjects had postoperative symptoms as against 45 per cent of the remaining subjects in the two groups. This difference is significant, using the chi square test with correction for continuity ($0.02 < P < 0.05$) (Siegel 1956, p. 109). The hypotensive group separately showed a slight tendency to longer incapacity for work and greater frequency of postoperative mental symptoms among the mentally vulnerable. The normotensive group showed no difference between vulnerable and other subjects for length of incapacity for work, but a slightly higher frequency of postoperative mental symptoms among its vulnerable members.

Effect of Hypotensive Anesthesia as Seen from Results of Present Study

by Mats Gruvstad and Lars Kebbon

There are a number of other factors than the kind of anesthesia that might make a difference to the mental sequels after operation, particularly the extent of the operation and amount of blood lost. Most of these, however, would appear from our analyses to have had little to do with the greater impairment we observed in the hypotensive group directly after operation. Some would, if anything, have tended to cause greater impairment in the normotensive than in the hypotensive group, and thus reduce the greater impairment we observed in the hypotensive group. The observations at the late re-examinations were probably less affected by these factors. All in all, we feel justified in assuming that the operated groups were virtually alike for other factors than the hypotension, and that any difference between them could reasonably be referred to the hypotension.

Our series was relatively small, but the statistical methods we chose made it possible to compare small groups. We were prevented by practical circumstances from studying a larger unoperated group, and one that was more comparable with the operated groups. Nevertheless, this group gave us a good opportunity to study the effects of the operations as, apart from operation, it was much similar to the two operated groups, for example, in features like ill-being, analgesics and myelographic examinations.

The differences between the individuals in the initial performance level and relatively large dispersions of the scores in the psychometric tests may mean less reliability in the measurements, but this could hardly have had a systematic influence on the difference between the groups in changes from prescores to postscores.

Naturally, the intraindividual changes observed at the late re-examinations were less reliable measures of the effect of hypotension

than the ones observed shortly after the initial examinations, particularly concerning psychiatric features.

Finally we fully realize that our results are only applicable to the surgical and anesthesiologic conditions obtaining in our series. However, the agreement between the independent psychometric and psychiatric observations at the immediate post-examinations, though the groups were of slightly different composition, points to the reliability of the observations, and likewise the agreement between the psychometric scores in the operated groups at the immediate and late re-examinations, though they were of slightly different composition on the two occasions.

Accordingly, we feel justified in drawing the following conclusions.

1. Hypotensive anesthesia causes more impairment in mental functions than normotensive anesthesia, an impairment that can be seen both on psychometric and psychiatric assessment. The degree of the impairment is dependent to a certain extent on the degree and duration of the induced hypotension. Functions involving mental speed and ability to shift seem to be most affected. The deterioration does not lead to a material reduction in the general performance level, being only detectable on comparison with subjects who have not undergone induced hypotension, and small in comparison with the mental reactions which always follow major operation.

2. The impairment due to the hypotension seems to last a little longer than the impairment due to operation. A slight amount of deterioration can still be detected in some psychometric results a year or more after the operation, but nothing on ordinary psychiatric assessment after this length of time.

3. The impairment in mental functions after induced hypotension does not seem to have any effect of practical importance on the subject's adjustment to society, working capacity, or subjective well-being.

Summary

The authors, a psychiatrist, psychologist and anesthetist, made a study of the effects of induced hypotension on cerebral functions. For subject material they chose patients with prolapse of the lumbar discs, one group operated on under general anesthesia and hypotension induced with trimethaphan, another operated on under normotensive anesthesia, and a third which did not undergo operation.

The patients were collected in consecutive order as they came to an orthopedic department, and the choice between hypotensive and normotensive anesthesia was made at random by the anesthetist until 40 cases had collected; after this the anesthetist was given the intelligence quotients in these cases and from then on it was arranged that the groups should be as much as possible alike in age, sex and intelligence quotient. Finally, a series of 32 cases of hypotensive anesthesia, 39 cases of normotensive anesthesia and 22 unoperated cases were collected.

The particulars of the anesthetic technique and induction of hypotension are described in detail. The hypotensive group was divided into cases of mild and severe hypotension according to the systolic blood pressure during the hypotension.

The psychiatrist and psychologist did not learn what form of anesthesia had been used in the cases of operation until after their examinations. The patients were told that the study was being made in order to find out how tired people got after operations of the kind in question, and never knew at any time that it had anything to do with the anesthesia.

The psychometric examinations were scheduled as follows: The patients were given a test battery two times before their operation (or the corresponding days after admission in the unoperated cases), generally the second and first day before, and the same battery each time. On the fourth and sixth day after the operation or after corresponding intervals in the unoperated cases, they were given the battery twice again. About a year and a half later, the battery was given once more.

The psychometric battery consisted of measurement of single and choice reaction time, a finger dexterity test, a mirror tracing test, the identical forms test, measurement of the flicker fusion rate, determination of serial tone-length judgment, and the color-word interference test. At one of the pretests they were also given the SRB test for general intellectual level.

The psychiatric examinations were scheduled as follows: Shortly after the patients were admitted, they were interviewed by the psychiatrist who made a pre-appraisal of their mental state. Between the third and seventh day after the operation, or after a corresponding interval after the pre-appraisal, he made an immediate post-appraisal. About a year and a half later he made a late post-appraisal.

The psychiatrist assessed, purely from his impressions at the respective interviews, the patients for rate of thought, spontaneous flexibility, level of wakefulness, fatiguability and degree of initiative. At the pre-appraisal and immediate post-appraisal he also assessed three features which might have influenced the ratings for the first five items, viz., degree of pain, amount of tension and basic mood. He rated all eight items on a nine-point continuum with the rating of 5 representing the hypothetical normal midpoint.

The groups were compared for intraindividual changes in psychometric scores and psychiatric ratings from pre-examination to post-examinations. The significance of differences between the groups was tested with the Kruskal-Wallis one-way analysis of variance by ranks when it was a question of comparing more than two groups, and with the Mann-Whitney *U* test when two groups were compared.

Twenty-four of the hypotensive cases were examined completely according to the two schedules, 24 of the normotensive cases, and 11 of the unoperated cases. All but one of the remaining cases were included in different sections of the psychometric or psychiatric analysis, or both.

The following observations were made in the psychometric analysis:

At both immediate post-examinations, the hypotensive group showed greater impairment or less improvement through practice than the normotensive group in all the tests and subtests, and still greater impairment than the unoperated group. However, none of the postoperative scores in the hypotensive group pointed to gross functional disorder, the greater impairment being only detectable on comparison with the group operated on under normotensive anes-

thesia. In 4 of the 7 tests the operated groups differed significantly in score shift from the second pretest. The cases of severe hypotension generally showed greater impairment than the cases of mild hypotension. When the scores of several single tests were added together, highly significant differences were noted between the three groups. The greatest impairment in the hypotensive group was noted in tests sampling psychomotor functions and mental speed.

The same differences were noted between the two operated groups in the late post-examinations, but then these only differed significantly in 1 of the 7 score shifts. When the scores on all the tests were added together, the hypotensive group proved to have an inferior composite score to that of the normotensive group, but the difference was not significant ($P = 0.08$). However, when the scores for the four tests which distinguished most between the groups at the immediate posttests were added together, the hypotensive group proved to have a significantly inferior composite score.

Nor did the scores show any signs of gross functional disorder at the follow-up study, and none of the trends that could be seen on analyzing the data were as stable as on the foregoing occasion. The cases of severe hypotension did not differ distinctly from the ones of mild hypotension.

The following observations were made in the psychiatric analysis:

At the immediate post-appraisal, the hypotensive group showed slightly greater impairment in rate of thought, flexibility and wakefulness, but not in fatiguability and initiative. The results in the two operated groups overlapped to a great extent. The impairment was greater in the two operated groups than in the unoperated group in every respect, indicating that the operation itself might have caused more impairment than the hypotension. No definite differences could be seen between the cases of severe and mild hypotension in psychiatric respects.

At the late post-appraisal only small differences were observed between the groups. Both the hypotensive and normotensive group had improved from the immediate to the late post-appraisal. Analysis of the changes from the pre-appraisal to the late post-appraisal showed slightly less improvement in flexibility in the hypotensive group, but in rate of thought, wakefulness, fatiguability and initiative the hypotensive group showed slightly greater improvement. However, both groups exhibited little change from the pre-appraisal in all five items.

Headache, dizziness and mental disorders like lethargy, impaired

ability to comprehend and concentrate, and forgetfulness, were often present for a few weeks after operation, regardless of what form of anesthesia was used. The two operated groups did not differ in the number of cases with transient headache and mental complaints, either for a short while after operation or persisting at the late post-appraisal. Cases with a previous history of mental disorder or with preoperative fear seemed to be more apt to get mental symptoms after operation.

Patients operated on under hypotensive anesthesia were not unfit for work longer than ones operated on under normotensive anesthesia. Nor did they show any reduction in working capacity referable to the hypotension, as judged by their own reports and information from the insurance authorities, or any greater frequency of requests for public relief after their operation.

The authors analyzed a number of outside factors that might have distorted their results, but as far as they could judge none of them were able to explain the psychometric and psychiatric differences they observed between their groups.

They concluded, therefore, that anesthesia combined with induced hypotension causes a slightly greater impairment in mental functions immediately after operation than does normotensive anesthesia, that vestiges of this impairment can still be observed in psychometric scores a year or so after hypotensive anesthesia, but nothing on psychiatric appraisal, and that the impairment has no practical effect on the subject's working capacity, adjustment to society or subjective well-being.

Appendix

The original material consisted of 32 cases of hypotensive anesthesia, 39 cases of normotensive anesthesia and 22 unoperated cases.

In the case reports which follow, the data on the operation are restricted to an account of the number of vertebrae exposed, to give a rough and brief measure of the extent of the operation. In 4 cases in the hypotensive group (13, 23, 25 and 31) and in 2 in the normotensive group (37 and 67), no other surgical measure was undertaken. In case 71a osteosynthesis was performed In the rest, operation was done according to the method described by Hirsch (1959).

SUBJECT MATERIAL UNDERLYING PSYCHIATRIC ANALYSES

Seven cases were excluded every time the groups were compared for psychiatric ratings or changes in ratings—cases 32 and 33 for anesthesiologic reasons, cases 31, 34 and 71 for reasons given in chapter 6, case 71a because the patient had undergone lumbar osteosynthesis, and case 71b because the patient did not undergo the whole schedule of psychiatric analysis and because it was a particularly complicated case.

Case 67 and case 68 were included in the unoperated group at the immediate post-appraisal, and in the normotensive anesthesia group at the late post-appraisal. In cases 61 to 66, 69 and 82–90, no immediate post-appraisal was made, in cases 11, 15, 20, 27, 70, and 91–93, no pre-appraisal or immediate post-appraisal. In cases 60, 61, 80, 81 and 90, no late post-appraisal was made. Accordingly, pre-appraisal and immediate post-appraisal data were forthcoming from 26 cases of hypotensive anesthesia, 26 of normotensive anesthesia, and 12 unoperated cases. The corresponding figures for late post-appraisal data were 26, 33 and 12. The subjective after-effects could be compared in 30, 34 and 19 cases, respectively.

PSYCHOMETRIC MATERIAL

Cases 32, 33 and 71 were excluded when the different groups were compared. Cases 31 and 34 were excluded when the data from the late posttests were analyzed.

Cases 14, 27, 36, 38, 65, 66, 76, 82, 83, 86, 88 and 89 were either not given the full set of psychometric examinations or not examined at all, and are therefore not included in the psychometric material. The patients in cases 1, 5 and 63 did not undergo the pretests or immediate posttests, but contributed to the late posttest data. Cases 61, 62, 67, 68 and 71b were included in the unoperated group for the pretests and immediate posttests, but were transferred to the normotensive group at the late posttests, as they had been operated on under normotensive anesthesia in the meantime.

Hypotensive Anesthesia Group

CASE 1. Male, aged 37, mild personality deviation, preoperative fear.

Trimethaphan 270 mg., lowest B. P. 88 mm., hypotensive area 0, pethidine 25 mg., trichlorethylene anesthesia 90 min., unilateral exposure L5–S1, hematoma.

After operation: sensory oversensitivity for at least 2 mos., dizziness, listlessness, impotence, anxiety reaction for 4 mos., consulted psychiatrist. Unfit for work 123 days. Recovered at late post-appraisal.

CASE 2. Male, aged 26, mild personality deviation, preoperative fear.

Trimethaphan 275 mg., lowest B. P. 71 mm., hypotensive area 10 mm.^{2}, pethidine 65 mg., trichlorethylene anesthesia 60 min., unilateral exposure L5–S1.

After operation: After symptom-free interval, severe depressive reaction, listlessness, impaired concentrating ability; consulted psychiatrist. Unfit for work 156 days. Recovered at late post-appraisal.

CASE 3. Male, aged 45.

Trimethaphan 470 mg., lowest B. P. 60 mm., hypotensive area 57 mm.^{2}, pethidine 25 mg., trichlorethylene anesthesia 40 min., unilateral exposure L4–5.

Unfit for work 34 days. No after-effects.

CASE 4. Female, aged 37.

Trimethaphan 545 mg., lowest B. P. 60 mm., hypotensive area 88 mm.^{2} trichlorethylene anesthesia 80 min., unilateral exposure L5–S1.

Unfit for work 56 days. No after-effects.

CASE 5. Female, aged 35.

Trimethaphan 345 mg., lowest B. P. 50 mm., hypotensive area 90 mm.^{2}, length of trichlorethylene anesthesia unknown, unilateral exposure of L4–5.

Unfit for work 75 days. No after-effects.

CASE 6. Male, aged 39; preoperative fear.

Trimethaphan 90 mg., lowest B. P. 40 mm., hypotensive area 110 mm.^{2}, pethidine 25 mg., trichlorethylene anesthesia 75 min., unilateral exposure L5–S1, bled 400 ml.

Unfit for work 81 days. No after-effects.

CASE 7. Male, aged 43.

Trimethaphan 55 mg., lowest B. P. 60 mm., hypotensive area 115 mm.^{2}, pethidine 37.5 mg., trichlorethylene anesthesia 60 min., unilateral exposure L4–5.

After operation: headache and dizziness, listlessness, asthenic depressive reaction, forgetfulness. Unfit for work 61 days. Unimproved at late post-appraisal.

CASE 8. Female, aged 43; preoperative fear.

Trimethaphan 115 mg., lowest B. P. 70 mm., hypotensive area 145 mm.^{2}, trichlorethylene anesthesia 45 min., unilateral exposure L4–5.

Transient speech impairment after operation. Unfit for work 87 days. Recovered at late post-appraisal.

CASE 9. Male, aged 32, slightly psychasthenic.

Trimethaphan 170 mg., lowest B. P. 70 mm., hypotensive area 165 mm.^{2}, pethidine 25 mg., trichlorethylene anesthesia 70 min., unilateral exposure L5–S1.

Unfit for work 52 days. No after-effects.

CASE 10. Female, aged 36; preoperative fear.

Trimethaphan 440 mg., lowest B. P. 40 mm., hypotensive area 177 mm.^{2}, trichlorethylene anesthesia 130 min., unilateral exposure L4–S1.

Unfit for work 209 days. No after-effects.

CASE 11. Male, aged 56.

Amount of trimethaphan administered unknown, lowest B. P. 70 mm., hypotensive area 220 mm.², pethidine 12.5 mg., trichlorethylene anesthesia 80 min., unilateral exposure L5–S1.

Unfit for work 55 days. No after-effects.

CASE 12. Male, aged 59.

Trimethaphan 275 mg., lowest B. P. 40 mm., hypotensive area 275 mm.², trichlorethylene anesthesia 55 min., unilateral exposure L4–5.

Postoperative fever. Unfit for work 130 days. No other after-effects.

CASE 13. Male, aged 41; preoperative fear.

Trimethaphan 165 mg., lowest B. P. 60 mm., hypotensive area 330 mm.², pethidine 25 mg., trichlorethylene anesthesia 80 min., exposure L4–S1 on right side and L4–5 on left.

After operation: listlessness, impaired ability to concentrate and sensory oversensitivity. Unfit for work 130 days. Unimproved at late post-appraisal.

CASE 14. Female, aged 48.

Trimethaphan 375 mg., lowest B. P. 55 mm., hypotensive area 330 mm.², trichlorethylene anesthesia 50 min., unilateral exposure L5–S1.

Unfit for work 66 days. No after-effects.

CASE 15. Female, aged 42.

Trimethaphan 335 mg., lowest B. P. 60 mm., hypotensive area 335 mm.², pethidine 12.5 mg., trichlorethylene anesthesia 45 min., unilateral exposure L5–S1.

Unfit for work 79 days. No after-effects.

CASE 16. Male, aged 37.

Trimethaphan 225 mg., lowest B. P. 50 mm., hypotensive area 360 mm.², pethidine 25 mg., trichlorethylene anesthesia 60 min., unilateral exposure L4–5, bled about 250 ml.

Unfit for work 62 days. No after-effects.

CASE 17. Male, aged 30.

Trimethaphan 160 mg., lowest B. P. 50 mm., hypotensive area 375 mm.², pethidine 25 mg., trichlorethylene anesthesia 60 min., unilateral exposure L4–S1.

Transient sensory oversensitivity after operation. Unfit for work 48 days. Healthy at late post-appraisal.

CASE 18. Male, aged 41; preoperative fear.

Trimethaphan 320 mg., lowest B. P. 50 mm., hypotensive area 380 mm.², pethidine 37.5 mg., trichlorethylene anesthesia 80 min., unilateral exposure L4–5.

Unfit for work 34 days. No after-effects.

CASE 19. Female, aged 36.

Trimethaphan 80 mg., lowest B. P. 55 mm., hypotensive area 410 mm.², trichlorethylene anesthesia 40 min., unilateral exposure L4–5, bled 500 ml.

After operation: asthenic reaction for 2 mos. with forgetfulness, difficulty in grasping intellectually and listlessness.

Unfit for work 117 days. Recovered at late post-appraisal.

CASE 20. Male, aged 20, with post-traumatic convulsive disorder (?).

Trimethaphan 120 mg., lowest B. P. 60 mm., hypotensive area 430 mm.², pethidine 25 mg., trichlorethylene anesthesia 85 min., unilateral exposure L4–5.

Unfit for work 50 days. No after-effects.

CASE 21. Female, aged 57.

Amount of trimethaphan administered unknown, lowest B. P. 40 mm., hypotensive area 440 mm.², pethidine 25 mg., trichlorethylene anesthesia 55 min., unilateral exposure L5–S1.

Transient sensory oversensitivity after operation. Unfit for work 128 days. Healthy at late appraisal.

CASE 22. Male, aged 42.

Trimethaphan 140 mg., lowest B. P. 50 mm., hypotensive area 610 mm.², trichlorethylene anesthesia 50 min., unilateral exposure L4–5.

After operation transient impairment in concentrating ability, and forgetfulness. Unfit for work 61 days. Memory defect still present at late post-appraisal.

CASE 23. Female, aged 34; many different operations; hysteroid personality; psychiatric care for depressive reaction 3 years earlier; preoperative fear.

Trimethaphan 95 mg., lowest B. P. 45 mm., hypotensive area 610 mm.², trichlorethylene anesthesia 95 min., bilateral exposure L4–S1, bled 450 ml.

After operation: headache for more than 2 mos.; asthenic and depressive reaction lasting 4 mos.; psychiatric in-patient care. Unfit for work 256 days. Recovered at late post-appraisal.

CASE 24. Male, aged 38; diabetes mellitus for 2 years, well controlled with insulin.

Trimethaphan 190 mg., lowest B. P. 50 mm., hypotensive area 630 mm.², pethidine 25 mg., trichlorethylene anesthesia 90 min., bilateral exposure L4–S1, bled 250 ml.

Sensory oversensitivity for at least two months after operation. Unfit for work 90 days. Recovered at late post-appraisal.

CASE 25. Male, aged 49; fractured ribs and bruised thighs in accident a year previously; neurotic maladjusted person; preoperative fear.

Trimethaphan 75 mg., lowest B. P. 50 mm., hypotensive area 705 mm.², trichlorethylene anesthesia 80 min., bilateral exposure L4–S1, bled 450 ml.

Unfit for work 130 days. No after-effects.

CASE 26. Male, aged 59.

Trimethaphan 70 mg., lowest B. P. 50 mm., hypotensive area 725 mm.², pethidine 25 mg., trichlorethylene anesthesia 60 min., unilateral exposure L4–5.

Unfit for work 130 days. No after-effects.

CASE 27. Female, aged 53.

Trimethaphan 130 mg., lowest B. P. 4 mm., hypotensive area 846 mm.², trichlorethylene anesthesia 80 min., unilateral exposure L5–S1.

Impaired recent memory after operation. Unfit for work 284 days. Memory defect still present at late post-appraisal.

CASE 28. Male, aged 52.

Trimethaphan 200 mg., lowest B. P. 50 mm., hypotensive area 960 mm.², pethidine 45 mg., trichorethylene anesthesia 50 min., unilateral exposure L4–5.

Unfit for work 58 days. Defective recent memory and cervical root disorder noted at late post-appraisal.

CASE 29. Male, aged 38.

Trimethaphan 240 mg., lowest B. P. 50 mm., hypotensive area 1,030 mm.², trichlorethylene anesthesia 75 min., unilateral exposure L3–4, bled about 700 ml.

Unfit for work 110 days. No after-effects.

CASE 30. Male, aged 33.

Trimethaphan 125 mg., lowest B. P. 50 mm., hypotensive area 1,125 mm.^{2}, trichlorethylene anesthesia 30 min., unilateral exposure L5–S1.

Transient sensory oversensitivity after operation. Unfit for work 50 days. Recovered at late post-appraisal.

CASE 31. See chapter 6.

CASE 32 and 33. Excluded for anesthesiologic reasons.

CASE 34. See chapter 6.

Normotensive Anesthesia Group

CASE 35. Male, aged 51.

Pethidine 75 mg., trichlorethylene anesthesia 80 min., unilateral exposure L4–5, bled 250 ml.

Listlessness, impaired ability to concentrate and remember for 2 mos. after operation. Unfit for work 55 days. Similar but milder defects at late post-appraisal.

CASE 36. Male, aged 19.

Pethidine 25 mg., trichlorethylene anesthesia 80 min., unilateral exposure L4–S1, small dural lesion.

Unfit for work 113 days. No after-effects.

CASE 37. Male, aged 43.

Pethidine 25 mg., trichlorethylene anesthesia 95 min., unilateral exposure L4–S1.

Unfit for work 54 days. No after-effects.

CASE 38. Male, aged 34.

Pethidine 25 mg., trichlorethylene anesthesia 40 min., unilateral exposure L4–S1.

Unfit for work 41 days. No after-effects.

CASE 39. Male, aged 42, chronic alcoholism. Attacks of severe discontent. Psychiatric out-patient.

Pethidine 50 mg., trichlorethylene anesthesia 40 min., unilateral exposure L5–S1. Infected hematoma.

Unfit for work 81 days. After healthy interval short episode of strong discontent and anxiety neurosis.

CASE 40. Male, aged 52, mild tendency to anxiety states.

Pethidine 25 mg., trichlorethylene anesthesia 75 min., unilateral exposure L4–5.

After operation: dizziness. Unfit for work 59 days. Recovered at late post-appraisal.

CASE 41. Female, aged 25, slight feeblemindedness and hysterical reactions, psychiatric in-patient 1 year ago, preoperative fear.

Trichlorethylene anesthesia 35 min., unilateral exposure L5–S1.

After operation: listlessness and impaired ability to concentrate for 2 mos. Unfit for work 45 days. After healthy interval, several attacks of depressive reaction. Recovered at late post-appraisal.

CASE 42. Male, aged 37, preoperative fear.

Trichlorethylene anesthesia 70 min., unilateral exposure L4–5.

After operation: transient sensory oversensitivity. Unfit for work 48 days. Recovered at late post-appraisal.

CASE 43. Male, aged 22.

Pethidine 22.5 mg., trichlorethylene anesthesia 65 min., unilateral exposure L5–S1.

After operation: transient sensory oversensitivity. Unfit for work 33 days. Recovered at late post-appraisal.

CASE 44. Male, aged 37; psychomotor fits since childhood, hysteroid, maladjusted person, preoperative fear.

Pethidine 25 mg., arrhythmia at induction with trichlorethylene anesthesia, afterwards only nitrous oxide and oxygen, anesthesia 120 min. Unilateral exposure L4–5, bled 400 ml.

After operation: mild defects for one month, followed by strong discontent; barbiturate intoxication 1 year later. Unfit for work 236 days. Recovered at late post-appraisal.

CASE 45. Male, aged 32.

Trichlorethylene anesthesia 100 min., unilateral exposure L4–5, headache (myelography or dural lesion?).

After operation: headache, sensory oversensitivity, listlessness, impaired ability to remember and asthenic reaction for 2 mos. Unfit for work 134 days. Persisting memory defects 2 years after operation.

CASE 46. Male, aged 63.

Trichlorethylene anesthesia 60 min., unilateral exposure L5–S1.

After operation: asthenic reaction for 2 mos., with mild memory defects. Unfit for work 312 days. Still defective memory at late post-appraisal.

CASE 47. Male, aged 40, passive-aggressive personality, bronchial asthma, preoperative fear.

Pethidine 20 mg., trichlorethylene anesthesia 35 min., unilateral exposure L5–S1.

After operation: listlessness and forgetfulness. Patient himself said he had regressed to a lower level. (Prolonged emotional conflict.) Unfit for work 78 days. Unimproved at late post-appraisal.

CASE 48. Male, aged 21, preoperative fear.

Trichlorethylene anesthesia 100 min., unilateral exposure L4–5, hematoma.

Unfit for work 63 days. No after-effects.

CASE 49. Male, aged 37.

Trichlorethylene anesthesia 70 min., unilateral exposure L5–S1.

Unfit for work 45 days. No after-effects.

CASE 50. Male, aged 50.

Pethidine 25 mg., length of trichlorethylene anesthesia unknown, unilateral exposure L4–5.

Unfit for work 79 days. No after-effects.

CASE 51. Female, aged 34, asthenic personality, preoperative fear.

Trichlorethylene anesthesia 60 min., unilateral exposure L5–S1.

After operation: headache. Unfit for work 131 days. Cancerophobia, mild anxiety state at late post-appraisal.

CASE 52. Female, aged 38, mild asthenic traits.

Pethidine 25 mg., trichlorethylene anesthesia 80 min., unilateral exposure L4–5.

After operation: listlessness, impaired ability to concentrate and depressive reaction for 3 mos. Unfit for work 105 days. Recovered at late post-appraisal.

CASE 53. Male, aged 53, osteoarthritis of the hip joints.

Pethidine 25 mg., trichlorethylene anesthesia 30 min., unilateral exposure L4–5, small dural lesion.

Unfit for work 402 days. Disabled by hip disease at late post-appraisal.

CASE 54. Female, aged 30.

Pethidine 25 mg., trichlorethylene anesthesia 60 min., unilateral exposure L5–S1.

After operation: dizziness, mild asthenic reaction. Unfit for work 132 days. Recovered at late post-appraisal.

CASE 55. Male, aged 42, preoperative fear.

Trichlorethylene anesthesia 45 min., unilateral exposure L4–5.

After operation: transient sensory oversensitivity. Unfit for work 96 days. After healthy interval, forgetfulness and listlessness.

CASE 56. Female, aged 17.

Pethidine 25 mg., trichlorethylene anesthesia 45 min., unilateral exposure L4–5, hematoma.

Unfit for work 39 days. No after-effects.

CASE 57. Female, aged 36, hysteroid person. Psychiatric care for suicidal gesture 4 years ago.

Pethidine 25 mg., trichlorethylene anesthesia 75 min., unilateral exposure L4–5, bled 500 ml.

After operation: fever, mild depressive reaction. Unfit for work 128 days. Recovered at late post-appraisal.

CASE 58. Female, aged 47, preoperative fear.

Trichlorethylene anesthesia 50 min., unilateral exposure L4–5, bled 500 ml.

After operation: asthenic reaction. Unfit for work 134 days. Recovered at late post-appraisal.

CASE 59. Male, aged 26.

Trichlorethylene anesthesia 55 min., unilateral exposure L5–S1.

After operation: listlessness, sensory oversensitivity. Unfit for work 99 days. Recovered at late post-appraisal.

CASE 60. Male, aged 43.

Pethidine 12.5 mg., trichlorethylene anesthesia 105 min., unilateral exposure L4–5.

Unfit for work 61 days. Did not return for late post-appraisal.

CASE 61. Male, aged 20, preoperative fear.

Trichlorethylene anesthesia 45 min., unilateral exposure L5–S1.

Unfit for work 56 days. Did not return for late post-appraisal.

CASE 62. Male, aged 39.

Trichlorethylene anesthesia 105 min., unilateral exposure L4–S1.

Unfit for work 76 days. No after-effects.

CASE 63. Female, aged 54.

Trichlorethylene anesthesia 55 min., unilateral exposure L5–S1, headache, dural lesion.

After operation: headache and dizziness; asthenic reaction, prolonged defect in ability to concentrate and remember, listlessness, sensory oversensitivity. Unfit for work 100 days. Recovered at late post-appraisal.

CASE 64. Male, aged 44, preoperative fear.

Pethidine 25 mg., trichlorethylene anesthesia 105 min., unilateral exposure L5–S1, bled 400 ml., headache + cervical rigidity (dural lesion).

After operation: transient sensory oversensitivity. Unfit for work 55 days. Defective recent memory at late post-appraisal.

CASE 65. Male, aged 46.

Pethidine 25 mg., trichlorethylene anesthesia 115 min., unilateral exposure L4–S1, bled 500 ml., headache + cervical rigidity.

Unfit for work 97 days. No after-effects.

CASE 66. Female, aged 38, passive dependent, maladjusted person; preoperative fear.

Trichlorethylene anesthesia 105 min., unilateral exposure L4–S1.

After operation: depressive reaction, difficulty in concentrating and grasping a situation. Unfit for work 94 days. Recovered at late post-appraisal.

CASE 67. Male, aged 48, outgoing, maladjusted person.

Pethidine 25 mg., trichlorethylene anesthesia 75 min., unilateral exposure L4–S1.

Unfit for work 191 days. At late post-appraisal: depressive reaction. Marital conflict and socioeconomic problems.

CASE 68. Female, aged 36, hip operation one year ago.

Trichlorethylene anesthesia 100 min., unilateral exposure L5–S1.

After operation: orthostatic sensations. Unfit for work 83 days. Recovered at late post-appraisal.

CASE 69. Male, aged 44.

Pethidine 25 mg., trichlorethylene anesthesia 60 min., unilateral exposure L4–5.

Unfit for work 53 days. No after-effects of any kind observed.

CASE 70. Male, aged 36, no pre-appraisal performed.

Trichlorethylene anesthesia 80 min., unilateral exposure L5–S1.

After operation: impaired ability to concentrate and remember. Unfit for work 47 days. Unimproved at late post-appraisal.

CASE 71. See chapter 6.

CASE 71 a. Male, aged 41, operated on seven months before present study was started for prolapse of the lumbar discs. The patient was a maladjusted person, possibly addicted to drugs.

Trichlorethylene anesthesia 95 min., unilateral exposure and osteosynthesis of L3–S1.

Unfit for work 166 days. Transient reactive discontent, headache and dizziness after operation. Late psychometric posttests pointed to recovery.

CASE 71 b. Female, aged 43, formerly healthy.

The pretests and immediate posttests were given shortly before the first operation.

Trichlorethylene anesthesia 65 min., unilateral exposure of L5–S1; uneventful operation and postoperative course.

Two years later, the patient was operated on again because of persisting sciatica. Pethidine 25 mg., halothane anesthesia 200 min., unilateral exposure and osteosynthesis of L4–S1. The operation went smoothly.

Two hours after an injection of ketobemidon the patient suddenly lost consciousness, and had what appeared to be a focal epileptic fit, which was then followed by attacks of generalized convulsions for two hours. She was put in a respirator for 12 hours, and after injections of anticonvulsants, she had no more seizures. Two days passed before she became clear again. After that recovery was uneventful.

Neurologic examination was done two months later. Encephalograms revealed slight atrophy in the right frontal region, but no definite clinical abnormality otherwise. The patient could not remember anything of the events surrounding the operation. She suffered from a reactive depression, but showed no signs of a reduced intellectual level. Psychiatric examination three months after this second operation revealed a persisting amnesia for the time before and after operation, but no definite mental disorder.

The patient took anticonvulsant medicine for a year after this operation, but then stopped as she had no more attacks. Two years after the second operation she returned to the neurologic department for re-examination, and said then that she had still had no more attacks. Psychiatric examination at about the same time showed that she was still suffering from a mild reactive depression.

Unoperated Group

CASE 72. Male, aged 21, dreaded having an operation.

Unfit for work 72 days. No symptoms of psychiatric disorder reported at late post-appraisal.

CASE 73. Female, aged 35.

Unfit for work 53 days. No symptoms of psychiatric disorder reported at late post-appraisal.

CASE 74. Male, aged 43.

Unfit for work 26 days. No symptoms of psychiatric disorder reported at late post-appraisal.

CASE 75. Male, aged 52, alcoholism and social decline.

Unfit for work 200 days. Listlessness, forgetfulness, depressive reactions, psychiatric care, committed to institution for alcoholic addicts. Unimproved at late post-appraisal.

CASE 76. Female, aged 35, suspected encephalitis 4 years ago.

After hospital stay: depressive reaction, signs of convulsive disorder, vertigo. Unfit for work 5 days. Attacks of giddiness reported at late post-appraisal.

CASE 77. Male, aged 40, mild personality deviation, dreaded having an operation.

After hospital stay: anxiety reaction, persisting psychasthenia, forgetfulness. Unfit for work 70 days. Unimproved at late post-appraisal.

CASE 78. Male, aged 31.

After hospital stay: unfit for work 86 days. No symptoms of psychiatric disorder noted at late post-appraisal.

CASE 79. Female, aged 48.

After hospital stay: unfit for work 8 days. No symptoms of psychiatric disorder noted at late post-appraisal.

CASE 80. Female, aged 57, chronic otitis media, slightly feeble-minded, passive dependent person.

After hospital stay: unfit for work 1 day. Did not return for re-examination.

CASE 81. Male, aged 24.

Unfit for work 7 days. Did not return for re-examination.

CASE 82. Male, aged 54.

After hospital stay: headache and dizziness. Unfit for work 50 days. At late

post-appraisal mild presenile dementia with defective memory and concentrating ability, and listlessness.

CASE 83. Male, aged 47.

Unfit for work 90 days. Mild presenile asthenic reaction at late post-appraisal.

CASE 84. Male, aged 30.

Unfit for work 192 days. No symptoms of psychiatric disorder noted at late post-appraisal.

CASE 85. Female, aged 57.

Unfit for work 15 days. No symptoms of psychiatric disorder at late post-appraisal.

CASE 86. Female, aged 35.

Unfit for work 17 days. No symptoms of psychiatric disorder noted at late post-appraisal.

CASE 87. Male, aged 48, asthenic personality.

Unfit for work 20 days. No symptoms of psychiatric disorder noted at late post-appraisal.

CASE 88. Female, aged 38, had had attacks of anxiety with palpitation, dreaded having an operation.

After hospital stay: headache. Unfit for work 294 days. Treated one year later for drug addition. Unimproved at late post-appraisal.

CASE 89. Male, aged 49, mild tendency to anxiety states after encephalitis 7 years ago, dreaded having an operation.

Unfit for work 13 days. After coronary thrombosis 18 mos. later, psychiatric care for severe anxiety reaction.

CASE 90. Male, aged 25, personality deviation; maladjusted person; dreaded having an operation.

Unfit for work 39 days. Did not return for re-examination.

CASE 91. Male, aged 31.

Unfit for work 17 days. No symptoms of psychiatric disorder noted at late post-appraisal.

CASE 92. Male, aged 44.

Unfit for work 5 days. No symptoms of psychiatric disorder noted at late post-appraisal.

CASE 93. Male, aged 41.

Unfit for work 5 days. Treated for depressive reaction and alcoholism 1 year after hospital stay. Recovered at late post-appraisal.

Table A. *Individual Initial Ratings and Arithmetic Differences between Ratings at Pre-Appraisal and Immediate Post-Appraisal (DI) and between Pre-Appraisal and Late Post-Appraisal (DII) of Rate of Thought (A), Spontaneous Flexibility (B), Wakefulness (C), Fatiguability (D) and Degree of Initiative (E).*

Case No.	Age at Pre-Appraisal	Initial Rating					Arithmetic Difference									
							A		B		C		D		E	
		A	B	C	D	E	DI	DII	DI	DII	DI	DII	DI	DII	DI	DII
1	37	3	3	4	4	5	0	−3	0	−2	1	−1	2	−1	1	0
2	26	4	5	7	5	7	0	−2	1	1	2	0	1	−1	2	1
3	45	5	5	7	8	4	−1	−2	−1	−1	0	0	2	1	−2	−3
4	37	7	7	6	4	5	2	0	2	1	2	−1	−1	−2	0	0
5	35	7	4	7	4	2	2	1	1	0	2	3	−1	1	−2	−2
6	39	7	6	5	4	4	3	−1	1	−1	2	−1	1	−3	1	−1
7	43	4	6	6	7	4	0	−2	4	1	2	1	5	1	2	−2
8	43	7	7	7	6	3	2	0	2	2	2	1	0	1	0	−1
9	32	8	6	4	3	5	2	1	2	0	−2	−3	−2	−2	0	0
10	36	6	5	5	5	6	3	0	0	−1	1	−1	2	0	1	−1
12	59	6	4	6	7	5	2	0	1	−2	3	0	5	2	1	−1
13	41	6	5	5	2	6	3	3	3	2	3	−1	−2	−4	−2	−2
14	48	7	6	3	3	2	2	2	1	1	−3	−2	−1	−3	−1	−2
16	37	6	4	7	7	4	2	0	1	0	3	0	4	2	0	−2
17	30	7	4	6	5	6	2	0	0	−1	1	0	2	−1	1	0
18	41	3	4	6	6	5	−2	−2	0	−1	2	1	2	0	0	1
19	36	6	4	6	7	6	1	0	1	−3	1	0	3	2	1	1
21	57	7	6	7	7	5	3	0	1	1	3	1	2	0	0	−1
22	42	6	6	5	3	6	0	0	2	1	1	0	0	−2	0	3
23	34	6	8	6	3	7	2	−2	3	1	2	0	−1	−4	1	−1
24	38	3	4	3	6	3	0	−1	0	0	0	−1	1	0	0	−2
25	49	7	6	7	7	8	0	0	2	−1	2	0	2	1	2	1
26	59	6	3	5	6	5	3	3	1	1	2	2	1	1	2	−1
28	52	5	5	6	6	5	−1	0	2	1	0	−1	0	−2	0	−2
29	38	4	4	6	7	4	1	−1	1	0	1	1	1	3	−1	0
30	33	9	8	8	6	7	3	1	1	0	2	0	1	0	2	1
35	51	5	5	7	6	8	0	0	1	0	1	0	0	0	2	2
36	19	9	6	8	8	8	1	0	0	−2	2	−1	0	1	0	0
37	43	5	4	3	5	4	1	−1	0	0	0	−3	2	−1	1	−1
38	35	7	6	6	4	7	1	0	1	0	0	−1	−3	−3	0	2
39	42	7	5	6	7	6	0	0	0	−1	0	0	0	1	0	1
40	52	6	7	6	5	4	0	0	2	1	0	1	1	−1	−2	−1
41	35	7	7	7	4	4	1	0	3	0	3	0	1	−1	0	0
42	37	6	5	5	4	5	2	0	1	2	1	−1	1	−1	2	0
43	22	7	5	7	5	5	0	1	1	1	3	1	1	0	0	0
44	37	7	3	3	2	6	2	0	1	−3	0	−4	1	−5	4	−2
45	32	3	3	7	7	6	1	0	1	0	2	1	3	1	2	0
46	63	6	4	5	7	8	1	1	0	0	−1	2	0	3	0	3
47	40	4	3	3	3	7	0	−1	−1	−3	−1	−2	−1	−1	3	3

Table A cont. p. 104.

Case No.	Age at Pre-Appraisal	Initial Rating					Arithmetic Difference									
		A	B	C	D	E	A		B		C		D		E	
							DI	DII	DI	DII	DI	DII	DI	DII	DI	DII
48	21	6	4	7	7	3	−1	−1	0	−1	0	0	0	1	−2	−2
49	37	5	4	7	7	4	0	0	−1	−2	1	3	2	1	0	0
50	50	7	5	7	5	3	1	1	0	1	2	1	2	−1	−1	−2
51	34	7	6	5	3	3	2	0	1	1	2	−1	−1	−4	−3	0
52	38	6	7	6	5	5	3	0	2	2	2	0	1	0	0	0
53	53	4	4	5	5	4	0	−1	1	0	0	1	0	−1	−1	−1
54	30	8	7	8	6	6	2	0	1	0	3	2	3	−1	2	1
55	42	5	6	6	6	5	2	0	3	2	2	0	1	2	1	1
56	17	7	7	6	7	5	1	1	1	0	1	0	2	1	1	0
57	36	9	9	8	8	9	2	1	2	1	2	0	3	1	3	0
58	47	3	6	4	3	2	−2	−1	0	2	0	0	−2	−3	−3	0
59	26	7	6	7	7	6	1	0	1	0	1	0	2	0	0	1
60	43	5	6	7	7	6	−2	—	−1	—	0	—	0	—	−1	—
62	39	5	3	7	8	8	—	−1	—	−2	—	−1	—	0	—	1
63	54	8	7	7	7	5	—	1	—	1	—	0	—	2	—	1
64	44	8	5	7	4	4	—	0	—	−2	—	0	—	−2	—	−1
65	46	7	6	7	8	5	—	0	—	0	—	1	—	2	—	−2
66	38	7	5	6	4	4	—	0	—	−2	—	0	—	0	—	0
67**	48	6	5	8	7	6	—	−1	—	−2	—	2	—	2	—	0
68**	36	7	7	8	6	5	—	1	—	0	—	2	—	−1	—	0
69	44	8	7	8	7	6	—	0	—	0	—	0	—	1	—	1
72	21	7	7	6	5	3	1	0	1	3	0	1	2	−1	1	−2
73	35	7	7	7	7	4	0	0	0	1	0	0	0	0	−1	0
74	43	5	4	5	4	5	0	−3	−1	−1	0	−1	−1	−1	1	−1
75	52	4	3	6	4	3	−1	1	0	0	0	4	0	1	−3	−1
76	35	5	5	5	6	3	1	0	1	1	1	1	3	−1	−1	−1
77	40	6	5	7	5	5	−1	1	−1	1	1	4	0	2	0	0
78	31	6	6	7	8	5	0	1	1	0	0	1	2	1	0	0
79	48	8	7	8	7	6	2	1	1	0	1	2	0	1	1	2
80	57	6	6	6	6	6	1	—	1	—	0	—	0	—	−1	—
81	24	8	8	8	7	6	0	—	0	—	0	—	−1	—	0	—
82	54	3	2	6	7	6	—	0	—	0	—	2	—	3	—	1
83	47	3	3	8	7	7	—	0	—	0	—	5	—	2	—	2
84	30	4	3	6	7	3	—	−1	—	−1	—	0	—	1	—	0
85	57	7	5	5	4	3	—	0	—	1		0	—	1	—	−1
86	35	7	6	6	5	5	—	1	—	0	—	−1	—	0	—	−1
87	48	4	3	6	5	4	—	0	—	−1	—	0	—	−1	—	1
88	38	8	7	8	6	4	—	0	—	1	—	2	—	1	—	−3
89	49	7	5	3	3	5	—	1	—	0	—	−2	—	−1	—	1
67*	48	6	5	8	7	5	1	—	1	—	2	—	2	—	0	—
68*	36	7	7	8	6	6	1	—	0	—	0	—	1	—	1	—

*Cases 67 and 68 included in unoperated group for immediate post-appraisal data and in normotensive anesthesia group for late post-appraisal data.

Table B. *Individual Psychiatric Ratings at Pre-Appraisal (I) and Immediate Post-Appraisal (II) for Degree of Pain, Tension and Mood*

Case No.	Pain		Tension		Mood		Case No.	Pain		Tension		Mood	
	I	II	I	II	I	II		I	II	I	II	I	II
1	2	6	7	9	3	2	48	6	4	7	5	6	6
2	7	7	6	5	5	5	49	2	4	4	6	5	5
3	7	2	7	4	6	—	50	5	5	6	4	4	5
4	8	5	7	5	5	5	51	8	3	8	6	4	6
5	7	6	7	4	5	5	52	6	7	7	5	6	6
6	7	5	8	6	4	3	53	7	6	4	4	5	5
7	7	6	6	7	4	4	54	9	7	7	7	5	4
8	2	4	8	6	3	5	55	7	7	7	7	4	4
9	8	6	7	5	4	5	56	8	8	7	5	5	5
10	7	8	8	7	3	5	57	6	7	2	2	7	5
12	6	6	6	6	6	4	58	7	6	8	5	5	6
13	8	7	4	7	5	4	59	7	3	3	5	6	6
14	9	—	2	3	6	—	60	8	4	3	2	3	6
16	4	—	2	—	6	—	62	8	—	2	—	6	—
17	7	4	4	5	5	5	63	8	—	6	—	3	—
18	5	4	7	4	3	5	64	7	—	7	—	5	—
19	8	5	3	5	4	5	65	8	—	4	—	4	—
21	8	5	7	5	4	5	66	6	—	7	—	4	—
22	8	8	6	6	6	6	69	6	—	7	—	4	—
23	3	7	7	5	5	5	72	6	6	7	8	6	3
24	—	—	7	—	4	—	73	6	4	7	6	5	5
25	2	3	7	7	5	5	74	6	6	3	4	5	4
26	6	7	6	5	6	6	75	3	5	8	7	2	3
28	7	3	6	3	5	6	76	7	7	7	8	5	4
29	7	4	7	6	4	5	77	7	7	7	7	3	3
30	3	6	2	2	6	5	78	7	8	7	7	4	4
35	8	—	8	—	5	5	79	4	3	7	3	3	5
36	7	5	4	3	6	6	80	6	5	5	4	6	6
37	5	6	8	6	5	—	81	2	2	2	2	5	6
38	7	4	7	4	4	5	82	5	—	2	—	4	—
39	7	3	6	3	5	6	83	7	—	6	—	5	—
40	6	6	7	4	4	5	84	3	—	7	—	4	—
41	3	5	8	5	6	5	85	7	—	8	—	4	—
42	6	4	8	5	3	4	86	—	—	3	—	6	—
43	2	6	6	4	5	5	87	6	—	4	—	4	—
44	2	5	4	6	6	5	88	6	—	8	—	5	—
45	8	6	5	7	6	5	89	4	—	8	—	4	—
46	8	7	5	4	6	6	67*	6	6	3	5	7	4
47	—	—	8	5	5	5	68*	7	7	7	5	5	5

*Cases 67 and 68 included in unoperated group for immediate post-appraisal data.

Table C. *Correlations between Psychiatric Ratings for Pain, Tension and Mood on the one Hand and Rate of Thought, Flexibility, Wakefulness, Fatiguability and Initiative on the Other. All Subjects.*

	Rate of thought	Flexibility	Wakefulness	Fatiguability	Initiative
	Correlations between Ratings at Pre-Appraisal				
Pain	0.03	0.01	—0.00	0.12	0.21
Tension	0.03	0.12	—0.20	—0.35***	—0.38***
Mood	0.15	0.14	0.14	0.11	0.16
	Correlations between Ratings for Pain, Tension and Mood and Changes in Ratings for Above Variables at Immediate Post-Appraisal				
Pain	0.36**	0.31*	0.25	0.10	0.32*
Tension	0.17	0.28*	0.28*	0.25	0.31*
Mood	—0.19	—0.17	—0.38***	—0.35**	—0.44***

* significant at 5 per cent level of confidence
** " " 2 " " " " "
*** " " 1 " " " " "

Table D. *Means, Medians and Rank Means for Differences between Pre-Appraisal and Immediate Post-Appraisal. Ratings for Pain, Tension and Mood.*

(Note: positive difference-values and larger means denote lowering of degree of pain, tension and mood.)

Items	Hypotensive Anesthesia Group (n=22—24)	Normotensive Anesthesia Group (n=23—25)	Unoperated Group (n=12)	Significance of Differences between Operated Groups P
Pain				
Mean diff.	0.70	0.74	0.08	
Median diff.	0.88	0.67	0.07	
Rank mean	23.6	23.4	—	0.48 (0.48)
Tension				
Mean diff.	0.75	1.20	0.25	
Median diff.	1.00	1.29	0.17	
Rank mean	23.0	27.0	—	0.16 (0.16)
Mood				
Mean diff.	—0.23	—0.20	0.33	
Median diff.	—0.17	—0.12	0.10	
Rank mean	23.7	24.3	—	0.44 (0.44)

P-values in brackets computed with correction for tied ranks.

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